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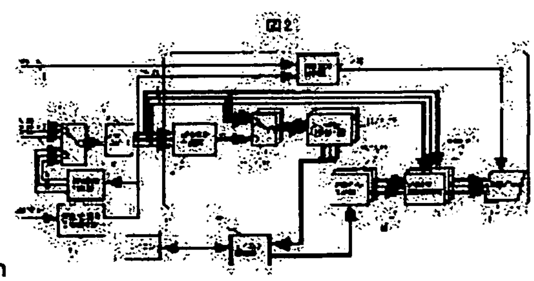
(54) LIQUID CRYSTAL DISPLAY DEVICE

(57)Abstract:
PROBLEM TO BE SOLVED: To provide a liquid crystal display device which displays clear video by obtaining an appropriate contrast in accordance with video data.
SOLUTION: Video characteristic (luminance distribution, maximum/minimum values and an average value) are obtained in an arbitrary interval from R, G and B video data inputted to input video characteristic detection sections 13 to 15 or luminance data and the characteristics are inputted to a microcomputer 23 through a microcomputer controlling section 24. The microcomputer 23 analyzes the data and outputs broken line point/master data and broken point correction data to broken line point generating sections 16 to 18 through a microcomputer control section 24 in order to obtain a good display condition. The sections 16 to 18 output broken line point data, that determine an output gradation characteristic, to between-points gradation computing section 19 to 21. In the sections 19 to 21 conduct computing processes using the broken line point data and the inputted R, G and B video data, obtain output gradation data between point and output the data to a display panel 4.



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CLAIMS

[Claim(s)]
[Claim 1] The liquid crystal display characterized by having the input image data characteristic detecting element which detects the brightness property over the gradation of said inputted image data in the liquid crystal display which displays image data, the gradation amendment section which amends said gradation according to said brightness property, and the liquid crystal panel which displays said amended gradation.
[Claim 2] Said gradation amendment section is a liquid crystal display characterized by amending said gradation so that the brightness of gradation with occurrence frequency higher than other gradation may become high relatively in said brightness property in a liquid crystal display according to claim 1 as compared with gradation besides the above.
[Claim 3] It is the liquid crystal display characterized by making said gradation amendment section high in the brightness of gradation with said high occurrence frequency in a liquid crystal display according to claim 2.
[Claim 4] Said gradation amendment section is a liquid crystal display characterized by making low the brightness of the gradation which adjoins gradation with said occurrence frequency high in a liquid crystal display according to claim 2.
[Claim 5] Said gradation amendment section is a liquid crystal display characterized by amending said gradation so that black may be emphasized, when gradation with high occurrence frequency is relatively located in a gradation side with low level in said brightness property in a liquid crystal display according to claim 1.
[Claim 6] Said gradation amendment section is a liquid crystal display characterized by amending said gradation so that white may be emphasized, when gradation with high occurrence frequency is relatively located in a gradation side with high level in said brightness property in a liquid crystal display according to claim 1.
[Claim 7] It is the liquid crystal display with which the brightness of the gradation with which said gradation amendment section includes the maximum brightness value in said brightness property in a liquid crystal display according to claim 1 is characterized by amending said gradation so that the maximum brightness value which can display said liquid crystal panel may be approached.
[Claim 8] It is the liquid crystal display with which the brightness value of the gradation with which said gradation amendment section includes the minimum brightness value in said brightness property in a liquid crystal display according to claim 1 carries out the description of amending said gradation so that the minimum brightness value which can display said liquid crystal panel may be approached.
[Claim 9] It is the liquid crystal display characterized by said input picture-characteristics detecting element detecting said brightness property in a liquid crystal display according to claim 1 for every one or more frame numbers of said inputted image data.
[Claim 10] It is the liquid crystal display characterized by said brightness property containing at least one of the luminance distribution in said 1 or multiple frame, the maximum brightness value, the minimum brightness value, and the average luminance values in a liquid crystal display according to claim 9.
[Claim 11] It is the liquid crystal display which is further equipped with the luminance-signal generation section which generates the brightness data of said inputted image data in a liquid crystal display according to claim 1, and is characterized by said input picture-characteristics detecting element detecting said gradation property based on said brightness data.
[Claim 12] In a liquid crystal display according to claim 1 said input image data characteristic detecting element The detection period setting section which sets up a detection period, and the number-of-partitions setting section which sets up the number of partitions which divides the gradation of said inputted image data, A luminance distribution detection means to accumulate the occurrence frequency of the gradation in the field divided by the number of partitions set as said number-of-partitions setting section during the

detection period set as said detection period setting section, The max and a minimum brightness detection means to detect the maximum brightness and the minimum brightness of each field divided by the number of partitions set as said number-of-partitions setting section during the detection period set as said detection period setting section, The liquid crystal display characterized by having an average luminance detection means to detect the average luminance of each field divided by the number of partitions set as said number-of-partitions setting section during the detection period set as said detection period setting section.
[Claim 13] The liquid crystal display characterized by having the gradation correction factor generation section which computes the correction factor in each gradation further in a liquid crystal display according to claim 1 from the occurrence frequency of the gradation detected by said input image data characteristic detecting element.
[Claim 14] It is the liquid crystal display characterized by computing as the straight line which connected between the set points which each gradation with which said gradation correction factor generation section was amended in said brightness property in the liquid crystal display according to claim 13 adjoins, a broken line, or a curve.
[Claim 15] The liquid crystal display characterized by having a liquid crystal panel, the back light which illuminates said liquid crystal panel, the input image data characteristic detecting element which detects the brightness property over the gradation of said inputted image data, and the back light control section which controls the quantity of light of said back light according to said brightness property in the liquid crystal display which displays image data.
[Claim 16] It is the liquid crystal display characterized by said brightness property containing the average luminance in one or more frames in a liquid crystal display according to claim 15.
[Claim 17] It is the liquid crystal display with which it sets to a liquid crystal display according to claim 15, and is characterized by said back light control section making the quantity of light of said back light in the one or more frames concerned smaller than the quantity of light in one or more frames besides the above when low as compared with the brightness in one or more [of others / brightness / in one or more frames] frames.
[Claim 18] It is the liquid crystal display with which it sets to a liquid crystal display according to claim 15, and is characterized by said back light control section making the quantity of light of said back light in the one or more frames concerned larger than the quantity of light in one or more frames besides the above when high as compared with the brightness in one or more [of others / brightness / in one or more frames] frames.
[Claim 19] Said back light control section is a liquid crystal display characterized by decreasing the quantity of light of said back light when the brightness of said inputted image data decreases in a liquid crystal display according to claim 15.
[Claim 20] It is the liquid crystal display characterized by making the quantity of light of said back light increase when the brightness of said inputted image data increases said back light control section in a liquid crystal display according to claim 15.

[Translation done.]

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention] This invention relates to the indicating equipment for displaying image data (image data and text data being included.), and relates to a liquid crystal display, a CRT (Cathode-Ray Tube) display device, a plasma display device, EL (Electro Luminescence) display device, etc. especially. What has a back light is contained in an indicating equipment.
[0002]
[Description of the Prior Art] As the color conversion approach of image data and its inverter from a picture signal generator, conventionally For example, as indicated by JP,11-275375,A The value out of range which the color value after conversion can take is also permitted about the lattice point data which take the strengthening location of the range which the color value after conversion can take to a multi-dimension look-up table. In case correction value is set up so that desired color conversion may be made if possible, and color conversion is performed Interpolation processing is carried out by interpolation operation part from the lattice point data which inputted into the address-generation section the chrominance signal which should carry out color conversion, and were outputted to it from the multi-dimension look-up table corresponding to the generated address. The color value after the conversion corresponding to the inputted chrominance signal is acquired, and in becoming the value out of range which the color value after conversion can take, it changes into boundary value by the gradation transducer.
[0003]
[Problem(s) to be Solved by the Invention] By however, the thing which the lattice point color value of the boundary section of the range which the color value after changing into a multi-dimension look-up table can take is set up with said conventional technique, and is done for data processing of between the lattice points Although the fundamental part that color conversion is possible is described without increasing the capacity of a look-up table Input image data were analyzed and the look-up table setting means for performing the optimal display doubled with the conditions of input image data was not described. Furthermore, with said conventional technique, although the color conversion approach by the image data based on a setup of a look-up table and the operation approach between the grids by the set point was described, control of a back light etc. was merged to this and a means to acquire a good display condition was not stated.
[0004] Furthermore, as other conventional examples, it is known that a liquid crystal display will perform expanding of bright gradation or dark gradation in a gamma correction circuit corresponding to the height of APL (AveragePicture Level) of a video signal, and will raise the contrast of the display image of a liquid crystal display. for example, JP,6-6820,A was equipped with gamma amendment memory which memorized gamma amendment data for white-level expanding, and gamma amendment memory which memorized gamma amendment data for black level expanding like the gamma correction circuit of a publication, by whether it is larger than the value which APL of a video signal set up beforehand, one of the gamma amendment memory of each above was chosen, and gamma amendment of a video signal was performed. According to the height of APL of a video signal, expanding of bright gradation or dark gradation can be performed in a gamma correction circuit by this, and the contrast of the display image of a liquid crystal display can be raised.
[0005] In addition to the image photoed with the video signal reproduced from others, VTRs, and DVDs, such as television broadcasting, as a video signal displayed on a liquid crystal display, or the video camera, the image created with computer graphics, a broadcast channel is sharply increased by the shift to digital broadcasting, such as satellite broadcasting service, from broadcast of the conventional analog type, and it is various as a source of a video signal. [image] Furthermore, it is thought that it does not remain under the category of the conventional television, but these video signals are incorporated also in a computer, add to

displaying the indicative data of the conventional computer, a video signal is processed and processed, and these various video signals come to be displayed on a display.
[0006] Thus, when displaying the video signal made various on a liquid crystal display, since it corresponds to the gradation property which all video signals have, the above-mentioned conventional technique which chooses one of the gamma amendment memory beforehand prepared according to the height of APL of a video signal, and does gamma amendment of a video signal needs to prepare many kinds of gamma amendment memory. [two or more] moreover -- actual -- a video signal -- time amount -- ** -- since a lot of memory is needed, both image scenes changing one after another, and preparing beforehand many optimal gamma amendment memory corresponding to each image scene only causes increase of cost, and it is not realistic. Moreover, on a different image scene, when APL is the same, the same gamma amendment memory is chosen, but by APL of a video signal, when APL is low, it is fair whether it is the image scene which has [whether the whole screen is an image scene dark on the average and] a bright part in the inside where most is very dark, I hear that the same gamma amendment is applied and gamma amendment memory is sometimes chosen, for example. In such a case, although different gamma amendment should be applied, since gamma amendment memory is chosen by APL of a video signal with the above-mentioned conventional technique, fine gamma amendment according to an image scene cannot be performed.
[0007] Moreover, although CRT widely used as a display until now is relation whose relation between an electrical signal and brightness is the 2.2nd [about] power, the amount of light and the relation of an electrical signal which penetrate liquid crystal as a liquid crystal display is shown in drawing 25 have the property all saturated with the darker one and the brighter one. gamma amendment of a video signal needed to be performed in consideration of such a characteristic property of a liquid crystal display.
[0008]
[Means for Solving the Problem] The purpose of this invention is by acquiring suitable contrast according to image data to offer the indicating equipment (and device) which can display an image vividly. A liquid crystal display is contained in a display.
[0009] Other purposes of this invention are by obtaining the quantity of light of a suitable back light according to image data to offer the liquid crystal display which can display an image vividly.
[0010] Other purposes of this invention are by obtaining the quantity of light of a suitable back light according to image data to offer the display which can reduce the power consumption for being able to improve the use effectiveness of the light of a back light, or making a back light publish. This invention detects the brightness property over the gradation of the inputted image data, amends gradation according to the brightness property, and displays the amended gradation on a liquid crystal panel.
[0011] And preferably, gradation is amended so that the brightness of gradation with occurrence frequency higher than other gradation may become high relatively in a brightness property as compared with other gradation.
[0012] Moreover, preferably, when gradation with high occurrence frequency is relatively located in a gradation side with low level in a brightness property, gradation is amended so that black may be emphasized.
[0013] Moreover, preferably, when gradation with high occurrence frequency is relatively located in a gradation side with high level in a brightness property, gradation is amended so that white may be emphasized.
[0014] Moreover, preferably, the brightness of the gradation which includes the maximum brightness value in a brightness property amends gradation so that the maximum brightness value which can display a liquid crystal panel may be approached.
[0015] Moreover, preferably, the brightness value of the gradation which includes the minimum brightness value in a brightness property amends gradation so that the minimum brightness value which can display a liquid crystal panel may be approached. Or this invention detects the brightness property over the gradation of the inputted image data, and controls the quantity of light of a back light according to a brightness property.
[0016] And when high as compared with the brightness in desirable 1 or two or more desirable frames of others [brightness / in 1 or two or more frames of arbitration] desirable again to which the brightness in 1 or two or more frames of arbitration makes small relatively the quantity of light of said back light when low as compared with the brightness in other 1 or two or more frames, the quantity of light of said back light is enlarged relatively.
[0017]
[Embodiment of the Invention] Hereafter, the 1st example of this invention is explained using a drawing. Drawing 1 is the block diagram showing the 1st example of the display system which used this invention

technique.

[0018] R [in / on drawing 1 and / in 1 / the period (for example, one frame period) of arbitration], The picture-characteristics detecting element which measures the brightness property of video signals, such as luminance distribution of G and B video signal, and the maximum and the minimum brightness, average luminance, The breaking point generation section which computes an amendment control point for 2 to carry out gradation amendment from the brightness property of the video signal detected by the input picture-characteristics detecting element 1, The broken line approximation gradation amendment section which amends the brightness property of a RGB video signal by the gradation amendment control point where 3 was generated in the breaking point generation section 2, and 4 are liquid crystal display panels which display the RGB video signal which had the gradation property amended.

[0019] For every frame of the video signal inputted from television broadcasting, a personal computer, video (VTR), DVD, etc., this invention searches for the brightness property of luminance distribution or video signals, such as the maximum and the minimum brightness, and average luminance, determines a gradation property for every frame by this, with the determined gradation property concerned, is performing gradation amendment to the above-mentioned video signal, and displaying on a liquid crystal display, and raises the feeling of MERIHARI and the clear feeling of display image quality. Hereafter, the detailed configuration and the actuation of the 1st of this invention example which are shown in drawing 1 are explained using drawing 2 thru/or drawing 14 .

[0020] In drawing 2 5 R from a personal computer (PC is called hereafter) etc., G, B analog video signal and the composite signal from video etc. R, G, B, the switching circuit which changes the changed signal, and 6 R from a switching circuit 5, G, the A/D converter which changes B analog output into digital data, The brightness / chrominance-signal separation control section from which 7 separates the composite signal from video etc. into a luminance signal and a chrominance signal, The signal-processing control section from which 8 changes the brightness and chrominance signal from the separation control section 7 into R, G, and B signal, The luminance-signal generation section in which 9 generates digital brightness data from digital one R from A/D converter 6, G, and B signal, The switching circuit where 10-12 change R from A/D converter 6, G, B output, and the luminance-signal output (Y) from the luminance-signal generation section 9, 13-15 are an input image data characteristic detecting element (it is hereafter called an "input picture-characteristics detecting element".) which detects the property of the input video signal of an arbitration period from the output from a switching circuit. The broken line point generation section which generates the output gradation data of each field boundary section at the time of 16-18 dividing an input whole floor tone field into the field of arbitration, The gradation operation part between the points which searches for the gradation property during the broken line point of the gradation field where 19-21 adjoin, The synchronizing signal control section to which 22 doubles the horizontal, perpendicular, and fly-back-line period signal of an input signal from PC or a composite with the timing of an output, The microcomputer with which 23 manages control by this whole control unit, the microcomputer control section to which control-section interface processing of a microcomputer 23 and others is performed, [24] The display panel with which 4 used liquid crystal etc. as an example of a display medium, 25 is the luminance-signal generation section 9, switching circuits 10-12, the input picture-characteristics detecting elements 13-15, the broken line point generation sections 16-18, and the gradation operation part between the points. The liquid crystal module (display device) containing 19-21, the synchronizing signal control section 22, and a display panel 4 is shown. It can be said that the broken line point generation sections 16-18 are operating as the gradation correction factor generation section for generating the correction factor for amending this based on an input video signal since a gradation property is changed according to an input video signal to an input video signal. The gradation operation part 19-21 between the points outputs the data amended by the correction factor generated in the gradation correction factor generation section to the input video signal.

[0021] Hereafter, the actuation about [whole] the 1st example by this invention is explained using drawing 2 . First, a switching circuit 5 chooses either of the signals which changed the composite image input from R, G, B analog image input, or video from PC etc. into R, G, and B analog signal. Here, in order to change a composite image input into R, G, and B analog video signal, after [R and G] separating into a luminance signal and a chrominance signal in brightness / chrominance-signal separation processing section 7 and making this signal into a color-difference signal by the signal-processing control section 8 first, it changes and outputs to B analog signal. They are inputted also into the luminance-signal generation section 9 while they are inputted into switching circuits 10-12, after R and G which were chosen in the switching circuit 5, and B analog video signal are changed into a digital signal by A/D converter 6. In the luminance-signal generation section, from R and G which are inputted, and B digital image data, the brightness value (Y) for every (a pixel here shows the data with which R, G, and B were doubled) pixel is calculated, and the result

is outputted to a switching circuit 10. Switching circuits 10-12 choose either R from A/D converter 6, G, B image data or the brightness data (Y) from the luminance-signal generation section 9, and output it to the input picture-characteristics detecting elements 13-15. The input picture-characteristics detecting elements 13-15 are circuits which detect the brightness property of the luminance distribution showing the rate of each brightness of appearing in one frame from R and G which were inputted, B image data, or brightness data (Y), or video signals, such as the maximum and the minimum brightness, and average luminance, for every frame. And it is possible to detect the property for every color by having each three color same circuits, in detecting from R, G, and B image data, and when detecting from the brightness data (Y) from the luminance-signal generation section 9 on the other hand, it is possible to search for the property for every pixel in one circuit. In the input picture-characteristics detecting elements 13-15, a gradation distribution property, gradation maximum and the minimum value, and the gradation average are detected from R and G which were inputted for every frame, B input image data, or brightness data (Y), and it outputs to the microcomputer control section 24. It is also possible to detect the brightness property of a video signal for every frame, when image data change frequently like the animation from video etc., and to detect the brightness property of a video signal for a multiple frame as one period, when there are comparatively few motions like the image from PC.

[0022] Next, the detection data in which the brightness property of the video signal detected by the input picture-characteristics detecting elements 13-15 is shown are sent to the microcomputer control section 24. The microcomputer control section 24 outputs detection data for the detection data from the input picture-characteristics detecting elements 13-15 to a microcomputer 23 according to the demand from a microcomputer 23. A microcomputer 23 generates broken line point data based on detection data, and outputs them to the microcomputer control section 24. In addition, about the detail of the generation method of broken line point data, it mentions later. The microcomputer control section 24 outputs broken line point data to the broken line point generation sections 16-18. In the broken line point generation sections 16-18, the broken line point data from the microcomputer control section 24 are outputted to the gradation operation part 19-21 between the points. According to the above-mentioned broken line point data, the gradation operation part 19-21 between the points changes the gradation property of R from A/D converter 6, G, and B digital image data, and outputs the gradation data after changing into a display panel 4. About the gradation operation part 19-21 between the points, also in any when the detection gestalt of input picture characteristics carries out in R, G, and B each color, or in case it carries out by the brightness data (Y) based on the luminance-signal generation section 9, since the digital image data from A/D converter 6 differ by R, G, and B, it has three lines.

[0023] Next, the detail of the function of each part is explained. Drawing 3 is the explanatory view of the luminance-signal generation section 9 in the 1st example of operation. The rate of each color in the case of generating brightness data (Y) from R, G, and B image data is for example, a bottom type.

Brightness data (Y) =0.299xR(red) +0.587xG(green) +0.144xB (blue)

The formula which computes this brightness data (Y) is the operation of the sum of products by which the multiplier of the real number was given to the image data of RGB, respectively, and it is difficult by increase of a circuit scale, processing speed fall, etc. to process this correctly by hardware. Then, an operation is simplified so that the operation of these sum of products can be easily realized by hardware. Here, since the generated brightness data were for itself not to become an indicative data and acquire the property of an indicative data, they were made to realize this by a shift and addition processing. In drawing 3 , it supposes that it is digital image data R, G, and whose B are 8 bits respectively, and R color is shifted 2 bits and rightward [5 bit] respectively (it becomes the division of 2 by carrying out 1 bit shift rightward, and is carrying out n bit shift). The following approximation processing to a top type is enabled by becoming the division of the n-th power of 2, carrying out, shifting G color 1 bit and rightward [4 bit] respectively, carrying out 3 bit shifts of the B color, and carrying out the guide peg of each shift data of all.

Brightness data (Y) =0.281xR(red) +0.563xG(green) +0.125xB (blue)

Since data processing for generating brightness data (Y) can be simplified by the above, it is easily realizable by hardware. In addition, software may realize.

[0024] Below, drawing 4 is used and the detailed configuration and actuation of drawing 2 of the input picture-characteristics detecting elements 13-15 are explained.

[0025] The detection period setting section to which 26 sets 1 time of a detection period in drawing 4 , the input gradation number-of-partitions setting section to which 27 sets the number of partitions of an input whole floor tone field, For 27, input image data are the input gradation number-of-partitions setting section. The input image data gradation field detecting element which detects to any of each division field set up by 28 it corresponds, The 1st gradation field counter with which 29 counts the data of the lowest field of

gradation, The 2nd gradation field counter with which 30 counts the same data of a field low to the 2nd, The n-th gradation field counter which counts the data of the field where 31 is same the highest, The 1st data hold latch for whom 32 holds the data total of the lowest field of gradation in 1 time of a detection period, The 2nd data hold latch for whom 33 similarly holds the data total of the 2nd field, The n-th data hold latch holding the data total of the field where 34 is same the highest, 35 is the 1st gradation field counter. m The counted value of 29 The m time multiplication circuit to double, Similarly 36 is the 2nd gradation field counter. *m [2] The counted value of 30 The 2*m time multiplication circuit to double, Similarly 37 is the n-th gradation field counter. The counted value of 31 n*m The n*m time multiplication circuit to double, The adder circuit where 38 adds the output data of each multiplication circuit, and 39 are an adder circuit. The n*m division circuit which does the division of the output of 38 by n*m, The average luminance data hold latch for whom 40 holds the output of the division circuit 39 as an average luminance value, The size comparator circuit which 41 compares the image data sent serially with the dot-data latch circuit 43 mentioned later, and chooses and outputs the data of the larger one, The size comparator circuit which 42 compares the image data similarly sent serially with the dot-data latch circuit 43 mentioned later, and chooses and outputs the data of the smaller one, The dot-data latch circuit to which 43 latches the output of the size comparator circuit 41, The dot-data latch circuit to which 44 similarly latches the output of the size comparator circuit 42, The maximum brightness data hold latch holding the maximum brightness data within the arbitration period when 45 was set up in the above-mentioned detection period setting section 26 in the output data of the dot-data latch circuit 43, 46 is the minimum brightness data hold latch holding the minimum brightness data within the arbitration period similarly set up in the above-mentioned detection period setting section 26 in the output data of the dot-data latch circuit 44.

[0026] Moreover, the luminance distribution detecting element 200 which detects the luminance distribution of input image data is equipped with the input image data gradation field detecting element 28, the 1st gradation field counter 29, the 2nd gradation field counter 30, the n-th gradation field counter 31, the 1st data hold latch 32, the 2nd data hold latch 33, and the n-th data hold latch 34. The brightness average detecting element 201 which detects the average of the brightness of input image data is equipped with the m time multiplication circuit 35, the 36 or n*m twice many 2*m time multiplication circuit [as this] multiplication circuit 37, an adder circuit 38, the n*m division circuit 39, and the average luminance data hold latch 40. The brightness max and the minimum value detecting element 202 which detects the maximum and/or the minimum value of brightness of input image data are equipped with the size comparator circuits 41 and 42, the dot-data latch circuits 43 and 44, the maximum brightness data hold latch 45, and the minimum brightness data hold latch 46.

[0027] First, 1 time of a detection period is set as the detection period setting section 26 by control from the microcomputer control section 24. By this example, since the contents of the display are changing for every frame like a video signal, the case where 1 time of a detection period is set up as one frame is explained. In addition, when the contents of the display hardly change like a personal computer, the detection period of the first floor may be set up as two or more frames. The output of the detection period setting section 26 serves as a latch clock for the last stage data hold latch of each detection function part so that it may mention later. On the other hand, the number which divides the magnitude of the brightness (for example, brightness data Y) of input image data is set up in the input gradation number-of-partitions setting section 27 by control from the microcomputer control section 24. Here, all input fields shall be made into 256 gradation (8 bits) as an example, and the number of partitions shall be set up comparatively for 8 minutes. The output from the input gradation number-of-partitions setting section 27 is inputted into the input image data gradation field detecting element 28. Here, the gradation value of input image data judges to any of the division field from the input gradation number-of-partitions setting section 27 it corresponds, and outputs the clock for field counters corresponding to the field. Here, the tonal range of each field serves as a field for every 32 gradation from an input whole floor tone field being [256 gradation and the number of partitions] 8. Therefore, since it also becomes increase of a circuit to improve precision, you may enable it to change precision by the application, although what is necessary is to enlarge the number of partitions and just to lessen the number of gradation of each division field, in order to improve the property detection precision of an input video signal. Luminance distribution is detected by counting the number of data for every gradation field with the 1st gradation field counter 29, the 2nd gradation field counter 30, and the n-th gradation field counter 31 with the clock from the input image data gradation field detecting element 28, and holding as luminance distribution data during the setting period by the detection period setting section 26 by the 1st data hold latch 32, the 2nd data hold latch 33, and the n-th data hold latch 34.

[0028] detection of the brightness average -- the 1st gradation field counter 29 and the 2nd gradation field counter 30 -- and The multiplication of each output of the n-th gradation field counter 31 is carried out m

times respectively in the multiplication circuit 35 and the 36 or n*m twice many 2*m time multiplication circuit [as this] multiplication circuit 37. Do each output in an adder circuit 38, and the division of addition and its output is done in the n*m division circuit 39. Average luminance in every frame is detected by holding the output as average luminance data by the average luminance data hold latch 40 for one frame by this example during the setting period by the detection period setting section 26. m means the number of gradation in each division field here. As stated above, an input is made into 256 gradation, and since it set up comparatively for 8 minutes, m of this example is set to 32. Therefore, 16 bit patterns, then the division circuit 39 serve as a division of n*m=8*32=256, and this can realize each multiplication circuit 35-37 and an adder circuit 38 in the simple logic of shift processing (8 bits of high orders are chosen) of 8 bits of right.

[0029] Brightness max and minimum value detection input into the size comparator circuit 41 and the size comparator circuit 42 dot-data latch circuit [which was delayed one clock to input image data and this] 43, and dot-data latch circuit 44 output, and judges and outputs the data of the larger one and the smaller one respectively. That is, since image data are sent serially, the dot-data latch circuit 43 is compared with image data in the size comparator circuit 41, and the data of the always larger one are chosen, it outputs to the dot-data latch circuit 43, and the data of the maximum brightness in every frame can be obtained by comparing all the image data for one frame. Moreover, it can carry out similarly by the size comparator circuit 42 and the dot-data latch circuit 44 about the minimum brightness. Max in every frame and detection of the minimum brightness are performed by latching the outputted data respectively by the dot-data latch circuit 43 and the dot-data latch circuit 44, and holding max and the minimum brightness data for one frame respectively by the maximum brightness data hold latch 45 and the minimum brightness data hold latch 46 during the setting period according the output to the detection period setting section 26.

[0030] Next, the detail of the broken line point generation sections 16-18 of drawing 1 is explained using drawing 5 .

[0031] Drawing 5 is the internal configuration Fig. of the broken line point generation sections 16-18. In drawing 5 , the broken line point setting register with which the input picture-characteristics feedback control section for reflecting the input characteristics detected from the input picture-characteristics detecting elements 13-15 when 47 set up the broken line point through the microcomputer control section 24, and 48 hold the light clock generation section for broken line point setting registers, and 49-57 hold the broken line point is shown respectively. Moreover, although there are the three broken line point generation sections 16-18 in drawing 2 , since it is the same configuration altogether, one line is explained in drawing 5 .

[0032] Moreover, in explanation of drawing 5 , the case where 256 gradation and an input whole floor tone field are divided into eight for the number of input gradation is explained to an example as well as explanation of the input picture-characteristics detecting elements 13-15. First, the case of the 1st example of a property the detection result from the input picture-characteristics detecting elements 13-15 is not made to reflect in is explained. The 1st example of a property is an example which sets up a property with equivalent input and output irrespective of the property detection result of the input picture-characteristics detecting elements 13-15. The input picture-characteristics feedback control section 47 sets up each broken line point master data from the microcomputer control section 24 directly. Therefore, in the 1st example of a property, the data of a linear property are directly set up from the microcomputer control section 24. The I/O gradation property by this setup is shown in drawing 6 . what the number of gradation between each division field is made equal for in drawing 6 (the number of gradation of 1 division field = 256 / 8= 32 gradation) -- I/O -- equivalence (linear) -- it becomes a property. In order to set up a linear property here, the detail of actuation of the input picture-characteristics period control section 47 is explained using drawing 7 R> 7.

[0033] Drawing 7 is the block diagram of the input picture-characteristics feedback control section 47. In drawing 7 , the switching circuit where 58 changes the broken line point amendment data and broken line point master data from the microcomputer control section 24, the broken line point data generation section in which 59 generates the register for broken line point amendment data-hold and 60 from broken line point amendment data and broken line point master data, and 61 show respectively a switching circuit 58 or the switching circuit which chooses either of the outputs from the broken line point data generation section 60. In the 1st example of a property which sets up the linear property shown in drawing 6 , first, a switching circuit 58 chooses the (1) side and the selection switching circuit 61 always chooses the (1) side. Therefore, irrespective of actuation of the broken line point calibration resistor 59 and the broken line point data generation section 60, the broken line point master data from the microcomputer control section 24 will be outputted as setting data of a direct broken line point register, and will be set as the broken line point setting registers 49-57. The broken line point setting register 49 outputs the broken line point 0. The broken line point setting register 50 Output the broken line point 1 and the broken line point setting register 51 outputs

the broken line point 2. Output the broken line point 3 and, as for the broken line point setting register 52, the broken line point setting register 53 outputs the broken line point 4. The broken line point setting register 54 outputs the broken line point 5, the broken line point setting register 55 outputs the broken line point 6, the broken line point setting register 56 outputs the broken line point 7, and the broken line point setting register 57 outputs the broken line point 8.

[0034] Although the above explained the 1st example of a property with linear input-output behavioral characteristics, the example of other input-output behavioral characteristics is explained hereafter, using drawing in order of.

[0035] The example which sets up the broken line point is first explained as 2nd example of a property reflecting the luminance distribution property from the input picture-characteristics detecting elements 13-15. It is the example which emphasizes the gradation field where occurrence frequency is high by raising the output brightness to the high input gradation field of occurrence frequency in the 2nd example of a property most among the detected luminance distribution property. The example of an I/O gradation property set as drawing 8 by the 2nd example of a property is shown. In this example, in the input picture-characteristics detecting elements 13-15, the brightness property of this field is emphasized noting that there is most occurrence frequency of the input gradation data to the division field 5. That is, a microcomputer 23 asks for a gradation field with most occurrence frequency from the gradation data occurrence frequency detected by the luminance distribution detecting element explained by drawing 4 . Consequently, supposing there are most fields 5, a gradation value (a) will be assigned to the broken line point calibration resistor 59 of the input picture-characteristics period control section 47 who showed drawing 7 by control from a microcomputer 23, and the master data of the broken line point 5 and the gradation data adding the broken line point calibration resistor's 59 set point will be set as the broken line point 5 setting register 54 in the broken line point data generation section 60. The brightness property of a field 5 becomes still steeper by this, and since the contrast of this gradation field 5 is raised, an image can be emphasized further.

[0036] Next, similarly as 3rd example of a property, the example which sets up the broken line point is explained reflecting the luminance distribution property from the input picture-characteristics detecting elements 13-15. An input gradation field is divided into two groups, a low field (field 1-field 4) and a high field (field 5-8), when most fields of the luminance distribution from the input picture-characteristics detecting elements 13-15 are located to a low field, black is emphasized, and in being in a conversely high field, it controls by this example to emphasize white. In this case, since actuation in case most fields of luminance distribution are located to fields 5-8 is the same actuation as the 2nd example of a property shown by drawing 8 , explanation is omitted. On the other hand, actuation in case most fields of luminance distribution are located to fields 1-4 is explained below with drawing 9 . The example of an I/O gradation property by the 3rd example of a property is shown in drawing 9 . In this example, it is supposed in the input picture-characteristics detecting elements 13-15 that there is most occurrence frequency of the input gradation data to the division field 4. That is, most fields of occurrence frequency are judged by control of a microcomputer 23 as well as actuation of the example of a property of the above 2nd. In this case, since it is a field 4, a microcomputer 23 is realized by assigning an amendment gradation value (b) to the broken line point calibration resistor 59 of the input picture-characteristics period control section 47 who showed by drawing 7 , and setting the gradation data which subtracted the broken line point calibration resistor 59 set point from the master data of the broken line point 3 as the broken line point 3 setting register 52 in the broken line point data generation section 60. In this case, the broken line point data generation section 60 constitutes a subtractor circuit. Since the brightness property of a field 4 becomes still steeper by this and the contrast of the field 4 concerned is raised, an image can be emphasized.

[0037] Next, as 4th example of a property, the example by which the 2nd and 3rd examples of a property were merged is explained. Also in this case, the broken line point is set up reflecting the luminance distribution property from the input picture-characteristics detecting elements 13-15. It controls from the luminance distribution property detecting elements 13-15 to emphasize the description of image data to a division gradation field with much max and the 2nd distribution. The example of an I/O gradation property by the 4th example of a property is shown in drawing 10 . In this example, in the input picture-characteristics detecting elements 13-15, there is most occurrence frequency of the input gradation data to the division field 6, and, subsequently it is considering as the division field 4. As opposed to the division field 6 Namely, the high group of an input gradation field sake, Add the broken line point calibration resistor's 59 1st correction value (a), and the master data of the broken line point 6 in the broken line point data generation section 60, and the division field 4 is received. For the low group of an input gradation field, the broken line point calibration resistor's 59 2nd correction value (b) It controls to emphasize the description of max and a division gradation field with much [the / 2nd] distribution by subtracting from the

master data of the broken line point 3 in the broken line point data generation section 60. In this case, the broken line point data generation section 60 constitutes the both sides of an adder circuit and a subtractor circuit.

[0038] Next, as 5th example of a property, it is an input picture-characteristics detecting element. The example which sets up the broken line point is shown reflecting the brightness maximum and the minimum value detection result from 13-15. The example of an I/O gradation property which reflected the maximum brightness detection result in drawing 11 R> 1 is shown. In this example, when the maximum brightness is contained to the field of the division field 7 and does not exist in the division field 8, the dynamic range of fields 1-7 is made into max. Therefore, make the set point of the broken line point 7 equal to the set point of the broken line point 8 to the broken line points 0-7, and be made to let the intersection of the broken line point 0 and each division field boundary section on the straight line which ties the broken line point 7 be each set point from the broken line point 1 to the broken line point 6 by the input picture-characteristics feedback control section 47 in drawing 5 . Taking advantage of the contrast which a display has by this, the whole brightness property can be made into homogeneity at the maximum, and the display property which lengthened the high brightness part can be acquired. Similarly, the example of an I/O brightness property which reflected the minimum brightness detection result in drawing 12 is shown. A dynamic range is made into max, when the minimum brightness is contained to the field of the division field 1 and does not fulfill the division field 0 with this example. That is, make the set point of the broken line point 1 equal to the set point of the broken line point 0, and be made to let the intersection of the broken line point 1 and each division field boundary section on the straight line which ties the broken line point 8 be each set point from the broken line point 2 to the broken line point 7. The whole brightness property can be made into homogeneity by this, and the property which lengthened the low brightness part can be acquired.

[0039] As mentioned above, it is possible to be able to acquire a good display condition and to acquire various I/O gradation properties about the brightness property given to image data, by making the detection result of the input picture-characteristics detecting elements 13-15 reflect in the broken line point generation sections 16-18. Of course, even if it does not make the detection result of the input picture-characteristics detecting elements 13-15 reflect, it is possible to change an input gradation property. Next, the gradation operation part 19-21 between the points in drawing 2 is explained using drawing 13 . The gradation operation part 19-21 between the points is for changing into the output gradation data during the point about input gradation data according to the broken line point set up in the broken line point generation sections 16-18. The block diagram of the gradation operation part 19-21 between the points is shown in drawing 13 . the case where have three lines so that it may set up independently, and it inputs in the each data [brightness] (Y) format based on the output from the luminance-signal generation section 9 in inputting the gradation operation part 19-21 between the points in R, G, and B format according to the input gestalt of the input picture-characteristics detecting elements 13-15 -- R, G, and B -- since it becomes common, it has one line. In drawing 1313 , the selector circuit where 62 chooses one from the set points of eight pieces other than the top gradation among the broken line point set points from the broken line point generation sections 16-18, the selector circuit where 63 similarly chooses one from the set points of eight pieces other than the lowest gradation, and 64 show respectively the gradation operation control section which asks for the gradation data during the point from the broken line point set point chosen by the selector circuit 62 and the selector circuit 63. Moreover, the case where an input whole floor tone field is made into eight division and input image data 256 gradation (8 bits) is similarly shown in an example. Since input image data are furthermore 8 bits, IND [this] [7:0] is written. Moreover, it writes POS0-POS8 [the broken line points 0-8], respectively.

[0040] First, the broken line point set point is respectively chosen from a selector circuit 62 and a selector circuit 63 by the high order triplet IND [7:5] among the input image data IND [7:0]. In a selector 62, it is a register from low order here. It inputs in order of POS0 to POS7, and is a register from low order in a selector 63. It inputs in order of POS1 to POS8. Supposing it follows, for example, the high order triplet IND of input image data [7:5] is "000", a selector circuit 62 will choose POS0, a selector circuit 63 chooses POS1, supposing IND [7:5] is "001" similarly, a selector circuit 62 will choose POS1 and a selector circuit 63 will choose POS2. According to the value of IND [7:5], POS0-POS8 are chosen like the following in selector circuits 62 and 63. The set point chosen from each selector is inputted into the gradation operation control section 64, performs data processing here, and obtains the gradation data of an output image. Actuation of the gradation operation control section 6403 performs the operation according to for example, a bottom type.

OUTD[7:0] = SEL1+(SEL2-SEL1) x -- IND [4:0]/32 -- here, OUTD [7:0] is - ** in the gradation after the operation which the gradation operation control section 64 outputs, and the broken line point with which

SEL1 was chosen by the selector 62, and SEL2 are the broken line points chosen by the selector 63. Drawing 14 shows the gradation property Fig. for explaining an upper type, and observes one division field. Moreover, the case where the high order triplet IND [7:5] of the input image data IND [7:0] is "100" is shown. A selector 62 chooses POS4, a selector 63 chooses POS5 from actuation of the gradation operation part 19-21 between the points, and it turns out that the input image data IND [7:0] are data in a field 5. Then, the gradation operation control section 64 calculates and outputs the output gradation OUTD [7:0] to IND [4:0] according to the formula after connecting between POS4 and POS5 in a straight line 5 bits of low order of input image data. This outputted OUTD [7:0] is changed according to the property that the input image data IND [7:0] are shown in drawing 6 , drawing 8 - Fig. 1212 , this OUTD [7:0] is outputted to a display panel 4, and an image is displayed.

[0041] As mentioned above, if it depends on the 1st example of this invention, by being able to set up a brightness property according to the gradation distribution property of the input image data for every frame period, the maximum brightness, and the minimum brightness, and emphasizing especially the contrast of the gradation distribution field where frequency is the highest, an image can be displayed vividly and it will become possible to perform the display in which the contrast property of a display was further harnessed according to the maximum and the minimum brightness.

[0042] In addition, it processed so that it might become the gradation property of the request of the property of the input video signal detected by the input picture-characteristics detecting elements 13-15 to origin with a microcomputer 23 using a microcomputer 23 and the microcomputer control section 24, and the broken line point generation sections 16-18 and the gradation operation part 19-21 between the points were controlled by the 1st example, the gradation property of an input video signal was changed, and it was outputting to the display panel. Then, in order to simplify circuitry more, it is good also as a configuration which inputs directly into the broken line point generation sections 16-18 the property of the input video signal detected by the input picture-characteristics detecting elements 13-15 not using a microcomputer 23 and the microcomputer control section 24. In this case, although the flexible control by the software of a microcomputer 23 becomes impossible and control action will be fixed by the circuit, the mark of the components about a microcomputer 23 are reducible. Therefore, it becomes possible to build in the circuit of this example in a liquid crystal module, and it becomes possible to realize the liquid crystal module which can set up a gradation property the optimal itself according to an input video signal. Drawing 15 is the block diagram showing the 2nd example which used this invention technique. In this example, it newly has the back light control section 65 for controlling the quantity of light of a back light to the 1st example. In addition, since it is the thing and identitas which were stated in the 1st example about other parts, detailed explanation is omitted. The concept of the light control of a back light is shown in drawing 16 . The light control of a back light is controlled by the detection result of the average luminance by the input picture-characteristics detecting elements 13-15. The brightness value Y is computed here from the image data inputted as average luminance, and it asks for the average of the brightness value Y for one frame. And when the 2nd example has high average luminance, the quantity of light of a back light is made to increase, and when average luminance is low, the quantity of light of a back light is decreased. Then, in addition to the 1st example which carries out gray scale conversion of the input image data, and is displayed on liquid crystal, by making the quantity of light of a back light control according to average luminance, it can see, as shown in drawing 16 , and the upper brightness can be fluctuated further. It is the description for this to attach MERIHARI of light and darkness to graphic display, and to display a powerful image. An example of the back light control action flow chart by this example is shown in drawing 17 . First, the broken line point set point is set as the broken line point generation sections 16-18 by the microcomputer 23 and the microcomputer control section 24. The broken line point set up at this time is as the 1st example having explained. Moreover, coincidence is asked for the average of the brightness to input image data by the input picture-characteristics detecting elements 13-15. A microcomputer 23 is processed according to the flow chart of drawing 17 R> 7 according to a brightness average value. A microcomputer 23 checks whether the brightness average is more than the gradation of a field 3 first. If it is not three or more fields, it will judge that input image data are darker, and the quantity of light of a back light will be lowered by the back light control section 65. Here, the precision of the average luminance for which it asked as an example about how far the quantity of light is lowered shall be 256 steps (8 bits), and the time of the adjustment value of a back light being in agreement with average luminance data also makes 256 gradation (8 bits) and the modulated light range of a back light a good display condition. In order that the input picture-characteristics detecting elements 13-15 may update detection data at spacing by the detection period setting section 26, according to this, back light control is also performed again. Here, spacing which carries out data detection is made into one frame. If the averages of detection brightness are three or more fields, it will check whether next it is six

or less field. If it is six or less field, it will be said that the average luminance detected after all is three or more fields and six or less field, and control of the back light quantity of light by the back light control section 65 is not performed. Conversely, if it judges that it is not six or less field, input image data will judge that it is a brighter image, and will raise the quantity of light of a back light by the same Argo REZUMU as the case of the image of eye dark. That is, since the quantity of light of a suitable back light can be obtained according to image data, an image can be displayed vividly.

[0043] As mentioned above, the example for which the back light quantity of light is adjusted according to the average luminance of a video signal is [2nd] effective in the ability to use effectively the light which a back light emits. Since liquid crystal is controlling the amount of the light which does not emit light itself but penetrates liquid crystal according to an indicative data, in order to consider this as a display, a back light is required for it. However, since it is always necessary to emit light while displaying, and most light of a back light will be intercepted with liquid crystal when especially the contents of a display are dark image scenes, this back light is bad in respect of the use effectiveness of light. However, in order to make the quantity of light of a back light fluctuate according to average luminance, the light of a back light is decreased at the time of a dark image, and the time of a bright image makes the light of a back light increase according to the 2nd example of this invention. Therefore, the power consumption for the use effectiveness of the light of a back light also improving, or making a back light emit light can also be reduced.

[0044] As mentioned above, according to this invention, by being able to set up a gradation property according to the gradation distribution property of the input image data for every frame period, the maximum brightness, and the minimum brightness, and emphasizing especially the contrast of the gradation distribution field where frequency is the highest, an image can be displayed vividly and it becomes possible to perform the display in which the contrast property of a display was further harnessed according to the maximum and the minimum brightness.

[0045] Furthermore, it becomes possible by building in the circuit of this example in a liquid crystal module to realize the liquid crystal module which can set up a gradation property the optimal itself according to an input video signal.

[0046] By adjusting the back light quantity of light according to the average luminance of a video signal, the use effectiveness of the light of a back light can be increased and the power consumption for making a back light emit light can also be reduced further again. Next, the 3rd example of this invention is explained using drawing 24 from drawing 18 . The 3rd example is an example which carries out gradation amendment without the more concrete configuration about the liquid crystal display which follows among the liquid crystal displays which perform gradation amendment according to the picture characteristics stated in the 1st example to detect especially luminance distribution, and performs gradation amendment, and using the microcomputer control section 24.

[0047] The sign used for the approximate account of each drawing used by explanation of the 3rd example of introduction and each drawing is explained.

[0048] Drawing 18 is the block diagram of the 3rd example of the liquid crystal display which applied this invention. The color video signal with which 71 is sent from sources of a signal, such as a personal computer and TV tuner, The histogram detector where 72 detects distribution of the brightness in one frame of the color video signal 71, The histogram value to which the histogram detector 72 outputs 73, the gradation control point calculation circuit where 74 computes the gradation control point for gamma amendment from the histogram value 73, The gradation control point where the amending [gradation] point calculation circuit 4 computes 75, the arbitration curvilinear gamma correction circuit where 76 amends the gradation of the color video signal 71 with the curve of arbitration from the gradation control point 75, The color display data with which gradation amendment of 77 was carried out in the arbitration curvilinear gamma correction circuit 76, and 78 are liquid crystal modules which perform color display by the color display data 77.

[0049] Furthermore, drawing 19 is drawing showing the configuration of the histogram detector 72 in drawing 18 , and Y value count circuit where 79 calculates Y value which shows brightness from the color video signal 71, and 80 are Y values calculated in Y value count circuit 79. Moreover, 81 is a pulse generating circuit, 82, 83, 84, 85, 86, 87, and 88 are pulse signals, and a pulse generating circuit 81 is a circuit which generates a pulse according to Y value in one of two or more pulse signals 82, 83, 84, 85, 86, 87, and 88. 89, 90, 91, 92, 93, 94, and 95 are counters, it is the counter which enumerates respectively two or more above-mentioned pulse signals 82, 83, 84, 85, 86, 87, and 88, and these counters are cleared for every frame. Thereby, the number of the pulses for every frame is enumerable. the counted value by which 96, 97, 98, and 99,100,101,102 were enumerated with the each above-mentioned counter, and 103 are latches, and latch 103 latches the counted value of each above for every frame, and holds it temporarily.

104, 105, 106, 107, 108, 109, and 110 are the counted value latched respectively, and this is the above-mentioned histogram value 73.
[0050] Furthermore, drawing 20 is drawing showing an example of the circuit of Y value count circuit 79 in drawing 19 . If R video signal is shifted to the 2-bit right, the signal of 0.25 will be outputted, and the signal of 0.0625 will be outputted if R video signal is shifted to the 4-bit right. Addition of the signal of 0.25 and the signal of 0.625 outputs the signal of 0.3125. If G video signal is shifted to the 1-bit right, the signal of 0.5 will be outputted, and the signal of 0.0625 will be outputted if G video signal is shifted to the 4-bit right. Addition of the signal of 0.5 and the signal of 0.0625 outputs the signal of 0.5625. The signal of 0.125 will be outputted if B video signal is shifted to the triplet right. And addition of the signal of 0.3125, the signal of 0.0625, and the signal of 0.125 acquires a luminance signal (Y).
[0051] Furthermore, drawing 21 is drawing showing the configuration of the gradation control point calculation circuit 74 in drawing 18 . 111 is a normalization circuit which normalizes the histogram value 73 of the brightness of the color video signal in one frame detected in the histogram detector 72 to the fixed average. The correction value count circuit which calculates correction value from the histogram value with which 112 was normalized, The corrected intensity generation circuit where 113 generates the corrected intensity k which shows the reinforcement of amendment, the criteria property generation circuit which generates the gradation amendment property that 114 becomes criteria, and 115 are adders, and the output of an adder 115 serves as the gradation control point 75. Furthermore, drawing 22 is drawing showing the configuration of the arbitration curvilinear gamma correction circuit 76 in drawing 1818 , 116, 117, and 118 are broken line approximation circuits which carry out gray scale conversion of the color display data 71 which consist of RGB, respectively, and after carrying out gray scale conversion of each broken line approximation circuit, it outputs the color display data 77 which consist of RGB respectively. Moreover, although the circuit of only R color of the color video signals 71 which consist of RGB is shown in the detail, since G color and B color can also be constituted from same circuit, drawing 22 has been omitted. In order that 119 and 120 may choose a correction factor 5, the selector controlled by the high order triplet of R color color video signal, the control point where 121 and 122 were respectively chosen by selectors 119 and 120, and 123 are straight-line approximation interpolation circuits calculated at 5 bits of low order and the control points 119 and 120 of R color color video signal.
[0052] Furthermore, drawing 23 is drawing which graph-ized the histogram value 73 outputted in the histogram detector 72 in drawing 18 .
[0053] Furthermore, drawing 24 is drawing which graph-ized relation between the input gradation of the arbitration curvilinear gamma correction circuit 76, and output gradation in drawing 18 .
[0054] Next, actuation of the 3rd example is explained to a detail. In drawing 18 , the color video signals 71 are the color data showing RGB, and are color display data including the video signal reproduced from others, VTR, and DVD, the image photoed with the video camera, the image created with computer graphics. [video signals /, such as a video signal which a personal computer outputs, and television broadcasting,] This color video signal 71 is respectively inputted into the histogram detector 72 and the arbitration curvilinear gamma correction circuit 76. The histogram detector 72 investigates the frequency distribution of the brightness of the color video signal 71 in one frame, outputs a result as a histogram value 73, and outputs it to the gradation control point calculation circuit 74. The gradation control point 75 for the gradation property amendment given to the arbitration curvilinear gamma correction circuit 76 based on the histogram value 73 is calculated, and the gradation control point calculation circuit 74 is outputted to the arbitration curvilinear gamma correction circuit 76. The arbitration curvilinear gamma correction circuit 76 carries out gradation amendment of the color video signal 71 so that the relation between input gradation and output gradation may serve as a property defined at the gradation control point 75, and it outputs it to the liquid crystal module 78 as color display data 77.
[0055] Furthermore, the detail of actuation of the histogram detector 72 is explained using drawing 19 , drawing 20 , and drawing 23 . Drawing 19 R> 9 is the detailed block diagram of the histogram detector 72. Y value the color video signal 71 inputted into the histogram detector 72 indicates the brightness of the color video signal 71 to be in Y value count circuit is calculated. by this example, the color video signal 71 is a color signal of RGB, and presupposes that it is RGB [of 8 bits of each (256 gradation)] digital data here. Then, at this time, Y value is defined by Y=0.299R+0.587G+0.114B, and Y value is calculated by count of an upper type from a RGB color signal. In addition, Y value turns into digital value of 8 bits.
[0056] by the way, although count of an upper type actually comes out, the multiplication of the real constant added to each value of RGB is approximated, and an approximation calculation circuit as shown in drawing 20 may be used. Generally, the circuit scale of a multiplier is large, and since it is especially the multiplier of the real number, it will become what has a very big scale. Then, count of Y value can be

approximated and RGB can reduce the scales of a circuit by approximating by count of a bit shift and addition taking advantage of the description which is the digital value of 8 bits respectively, rather than carrying out multiplication. Count of for example, R color adds a 2-bit right shift and a 4-bit right shift, and makes 0.3125 times as many R chrominance signal as this, and the approximation calculation circuit of drawing 20 adds it with a bit shift as similarly shown in drawing 20 , makes one 0.125 times the B color [one 0.5625 times the G color of this, and] of this, finally adds all, and calculates the Y value 80. Thus, the calculated Y value 80 is inputted into a pulse generating circuit 81 next.
[0057] A pulse generating circuit 81 is a circuit which carries out the pulse output of one of the pulse signals 82-88 according to the value of the Y value 80, and shows the detail of the actuation in Table 1.
[0058]
[Table 1]

表１

区分	Ｙ値８０	パルス出力
1	０～　３１	パルス信号８２
2	３２～　６３	パルス信号８３
3	６４～　９５	パルス信号８４
4	９６～１２７	パルス信号８５
5	１２８～１６９	パルス信号８６
6	１６０～１９１	パルス信号８７
7	１９２～２２３	パルス信号８８
8	—	—

As shown in Table 1, when the Y values 80 are 0-32, a pulse is outputted to a pulse signal 82, when the Y values 80 are 33-64, a pulse is outputted to a pulse signal 83, and corresponding to the value of the Y value 80, a pulse signal is outputted like the following. In addition, since the Y value 80 is the digital value of 8 bits as stated above, the range of the value which can be taken is 0 to 255. Although mentioned later, according to the number of the control points for performing gradation amendment of broken line approximation, the range of the value of the Y value 80 is equally divided into eight, a value is classified every 32 steps, and it was made to carry out a pulse output in this example according to the Y value 80. In addition, although there was no publication of the part in which the Y value 80 is equivalent to the partition 8 which shows between 224-255 in Table 1, when this asked for the partition 1 - the partition 7 correctly, since a meaning was asked for the partition 8, it omitted the circuit. That is, when display resolution is 640x480 pixels, since the total of a pixel is 307200 pixels, if the total of the pulse to a partition 1 - a partition 7 is known, I hear that it is called for from the total of a pixel, and there is. In addition, since it was uninfluential in actuation of this example so that it might mention later, the circuit equivalent to a partition 8 was omitted.
[0059] A pulse generating circuit 81 outputs pulse signals 82-88 to counters 89-95 respectively according to the Y value 80 as mentioned above. And as for counters 89-95, the Y value 80 enumerates a pulse respectively corresponding to a partition 1 - a partition 7. The value is held by latch 103 for every frame temporarily, and, as for the pulse number enumerated respectively, this is outputted as a histogram value 73. An example which graph-ized the histogram value 73 at this time is shown in drawing 23 . As shown in drawing 23 , the occurrence frequency of the Y value 80 is enumerated for every partition, and the frequency distribution of the brightness of the color video signal in one frame of this ** is acquired.
[0060] Moreover, although it is the histogram of drawing 23 , when I hear that many parts are occupied, it is and this color video signal 71 is displayed also in the color video signal 71 of the frame concerned, I hear that the gradation of the partition of H4, H5, and H6 with high frequency occupies much area of the display screen, and there is. I hear that there are few rates of on the other hand occupying the gradation of the partition of H1 and H2 with low frequency to the display screen, and there are. Therefore, the contrast of the indicative data of a gradation partition which occupies many of screen products can be emphasized, and contrast can be attached to a display by suppressing the contrast of the indicative data of a gradation partition with few rates of occupying to a screen product. Then, in quest of a gradation property, what is necessary is just made to change the gradation property of an indicative data from the frequency distribution of this histogram directly.
[0061] Next, actuation of the circuit which computes the gradation control point 75 is explained using drawing 21 from such a histogram value 73. Drawing 21 is the block diagram of the gradation control point

calculation circuit 74. The histogram value 73 calculated as mentioned above is inputted into the normalization circuit 111. The sum total of each frequency of the histogram value 73 is equal to display resolution, for example, in the case of the resolution of 640x480 dots, the sum total of frequency becomes 307200 pieces. Since the histogram value 73 classifies into eight division into equal parts 0-255 which the Y value 80 can take and asks for each frequency, the arithmetic average of the frequency of each partition is 1/8 of 38400 of the sum total of frequency. The normalization circuit 41 is a circuit which normalizes 38400 values of this arithmetic average to 32 pieces. In addition, let the frequency of each partition of the normalized histogram respectively be the normalization frequency H1-H7 like drawing 21 . Moreover, although the number of the arithmetic averages of the frequency after normalization is 32, they write the notation [this] delta.

[0062] Next, this normalization frequency H1-H7 is inputted into the correction value count circuit 112 with the corrected intensity k from the corrected intensity generation circuit 113, and the gradation correction value R1-R7 for gray scale conversion is computed. the correction value count circuit 112 -- the 1- it consists of the 7th correction value count circuit, and count according [each count circuit] to a degree type is made.

R1=k (H1-delta)

In a k(H6-delta)+R5R7=k(H7-delta)+R6 top type R2=k(H2-delta) +R1R3=k(H3-delta) +R3R4=k(H4-delta) +R3R5=k(H5-delta) +R4R6= -- Each variable is as given in drawing 21 , to the average delta of frequency, I hear that the difference of the normalization frequency H1-H7 becomes the gradation correction value R1-R7, and the place which this formula means has it. Therefore, when the value of the normalization frequency H1-H7 is larger than average delta, the gradation correction value R1-R7 turns into a forward value. When the value of the normalization frequency H1-H7 is smaller than average delta, the gradation correction value R1-R7 turns into a negative value. Since corrected intensity k is furthermore added to each formula as a multiplier, the magnitude of the gradation correction value R1-R7 can be changed by going up and down the value of corrected intensity k. such count -- the gradation correction value R1-R7 -- count -- it is respectively inputted into an adder 45.

[0063] An adder 45 is an add operation machine for amending to the reference points B1-B7 of the gradation property used as the criteria which the criteria property generation circuit 114 generates with the gradation correction value R1-R7 calculated in the correction value count circuit 112, and the value after addition serves as the gradation control points L1-L7. Although it is the reference points B1-B7 of a gradation property, this shows the gradation property used as the criteria for carrying out gradation amendment of the color video signal 71, and sets up the gradation property according to the histogram of brightness to these criteria.

[0064] A concrete numeric value shows actuation of the above gradation control point calculation circuits 74 by Table 2.

[0065]

[Table 2]

表2

制御点	正規化頻度 H_n	補正強度 K	階調補正値 R_n	基準点 B_n	階調制御 L_n
P_1	15		-8	32	24
P_2	32		-8	64	56
P_3	40		-4	96	92
P_4	48	0.5	4	128	132
P_5	49		12	160	172
P_6	38		15	192	207
P_7	18		8	224	232
	16				

正規化頻度の平均値δ＝３２（一定）

Table 2 shows between until it computes a gradation control point by the gradation control point calculation circuit 74 numerically from the histogram detected in one frame with the color video signal 71. Each

frequency H1-H8 of the normalized histogram makes an example a value as shown in Table 2. In addition, the average delta of this frequency H1-H8 is 32. The correction value count circuit 112 performs count according to several 2 about ******** among [H1-H7] this normalization frequency H1-H8. That is, from each normalization frequency H1-H7, as shown in Table 2, when corrected intensity k is set to 0.5, the gradation correction value R1-R7 is computed. On the other hand, reference points B1-B7 show the property used as the criteria for carrying out gray scale conversion of the color video signal 71, and amend a gradation property to this criteria property. The reference points B1-B7 of Table 2 serve as a value from which this criteria property turns into a linear property. The gradation control points L1-L7 are computed by adding respectively the gradation correction value R1-R7 to these reference points B1-B7. Thus, the computed gradation control points L1-L7 are outputted to the arbitration curvilinear line gamma correction circuit 76.
[0066] Next, actuation of the arbitration curvilinear gamma correction circuit 76 which carries out gradation amendment of the color video signal 71 inputted using the computed gradation control points L1-L7 is explained using drawing 22 . The arbitration gamma correction circuit 76 consists of three broken line approximation circuits 116, 117, and 118, and performs gray scale conversion of the color video signal of each color of RGB respectively. Although here explains actuation of the circuit of R color among each broken line approximation circuits, since the circuit of G color and B color also carries out same actuation, explanation is omitted. In drawing 22 , R color video signal is a 8 bits (256 gradation) digital video signal, among these a high order triplet is inputted as a selection-control signal of selectors 119 and 120. On the other hand, 5 bits of low order of R color video signal are inputted into the straight-line approximation interpolation circuit 123. In addition, it writes the notation [data of 5 bits of low order of R color video signal] c. R color video signal of a high order triplet inputted into selectors 119 and 120 chooses the gradation control points L1-L7, fixed value "0" F0, or fixed value "255" F255 according to the table of truth value of Table 3.
[0067]
[Table 3]

表３

映像信号上位３ビット	セレクタ１１９出力	セレクタ１２０出力
000	固定値"0"	Ｌ１
001	Ｌ１	Ｌ２
010	Ｌ２	Ｌ３
011	Ｌ３	Ｌ４
100	Ｌ４	Ｌ５
101	Ｌ５	Ｌ６
110	Ｌ６	Ｌ７
111	Ｌ７	固定値"255"

The selected signal is respectively inputted into the straight-line approximation interpolation circuit 123 as control points 121 and 122. In addition, the notation [a control point 121] a is written and the notation [a control point 122] b is written. Thus, based on the data c of 5 bits of low order of the selected control points a and b and R color video signal, the straight-line approximation interpolation circuit 123 is calculated by the degree type, and is outputted as R color gradation data after gradation amendment.
Gray scale conversion of the inputted color video signal 71 is carried out by the straight-line approximation interpolation circuit 123 y=a+(b-a) -c / besides [32] defined by the formula, it is outputted to the liquid crystal module 78 as color display data 77, and an image is displayed. As mentioned above, the arbitration curvilinear gamma correction circuit 76 shown in drawing 22 is that the gradation control point 75 is given, and the color video signal 71 is changed into it by the gradation property of arbitration, and it is outputted as color display data 77. Furthermore, this gradation transfer characteristic is explained using drawing 24 .
[0068] Drawing 24 is an example of gamma amendment property when applying the gradation conversion circuit by this invention to the criteria property of a linear property. Moreover, it explains, uniting and referring to Table 2. Since the criteria property is linear, reference points B1-B7 serve as a value which is respectively shown in Table 2, and when input gradation is "32", output gradation (reference point B1) is set up like [output gradation (reference point B-2)] "64" and the following, when "32" and input gradation are "64." According to the example of this invention, gamma amendment property of broken line approximation is controlled by control points P1-P7. The gamma characteristics of the broken line approximation obtained in these control points P1-P7 by making reference points B1-B7 go up and down according to the gradation correction value R1-R7 turn into the gradation transfer characteristic. The gradation control points L1-L7 are calculated by amending this with the gradation correction value R1-R7 to reference points B1-B7 in Table 2, and a ******** gradation property serves as the control points P1-P7 of drawing 24 at these

gradation control points L1-L7. After applying and carrying out gray scale conversion to the color video signal 71 into which such a gradation property was inputted, it outputs to the liquid crystal module 78 as color display data 77.

[0069] As mentioned above, according to the 3rd example, it can be adapted for the histogram of the brightness of the inputted color video signal 71, the contrast of the gradation of the high partition of frequency can be emphasized on a histogram, and the contrast of a display can be attached by suppressing the contrast of the gradation of the low partition of frequency. And in order are adapted for a color video signal and to perform contrast control, it can respond also to various video signals. Since image scenes, such as an animation, can perform always optimal contrast control also in the video signal which changes one after another especially, it can express as the optimal image quality in consideration of the display property which a liquid crystal display has, or contrast.

[0070] Next, the 4th example of this invention is explained using drawing 18 , drawing 19 R> 9, drawing 25 - drawing 28 . It is the description that gradation amendment which also took the gradation property peculiar to liquid crystal into consideration can be performed because the main point of the 4th example changes the property of the histogram detector 72 of the 3rd example of the above. The sign used for introduction each description of drawing and each drawing is explained. In addition, explanation of the sign of already explained drawing 18 and drawing 19 is omitted.

[0071] Drawing 25 is drawing showing the relation of the amount of light and electrical signal (electrical-potential-difference actual value) which penetrate the liquid crystal of a liquid crystal display.

[0072] Drawing 26 is drawing showing the relation between the input indicative data (gradation data) of a liquid crystal display, and the permeability of the light of liquid crystal.

[0073] Drawing 27 A and B is drawings showing signs that the partition of each histogram distribution is changed, to the relation between the input (gradation data) of a liquid crystal display, and the permeability of the light of liquid crystal.

[0074] It is drawing showing the detailed configuration of the pulse generating circuit 81 of drawing 19 in order that drawing 28 may realize the 2nd example, 130 is a threshold setting register, and the circuit which generates the thresholds S1-S7 used as the criteria for comparing with the value of the Y value 80, and 131-137 are comparator circuits which output a pulse corresponding to the value which compared the Y value 80 with thresholds S1-S7, and was defined with thresholds S1-S7.

[0075] Next, actuation of the 4th example of this invention is explained.

[0076] the reverse serpentine property that drawing 25 shows the relation of the amount of light and liquid crystal applied voltage (electrical-potential-difference actual value) which penetrate common liquid crystal, and the permeability of liquid crystal is all saturated with the one where permeability is higher, and the lower one -- **** -- it is. thus, the property in which liquid crystal changes the permeability of light -- **** -- it gets down, the light source (back light) is arranged for the background of liquid crystal in a liquid crystal display using this property, and brightness is changed by controlling the permeability of the light of through and liquid crystal for the light of this back light to liquid crystal. Therefore, the property of the brightness of a liquid crystal display is also equivalent to the property of drawing 25 about, and the permeability of the liquid crystal of the axis of ordinate of a property Fig. should just read it as the brightness of a liquid crystal display. The display information for displaying such a liquid crystal display is given as an indicative data (gradation data). Many of indicative datas are digital data with the bit width of face which can express multi-tone, such as 6 bits (64 gradation) or 8 etc. bits (256 gradation). Therefore, in order to display based on an indicative data, the driver circuit which changes this indicative data into liquid crystal applied voltage inside a liquid crystal display is built in. By this driver circuit, the relation between an indicative data (gradation data) and the permeability of liquid crystal becomes like drawing 26 . In many liquid crystal displays, in the reverse serpentine liquid crystal transmission property, the relation between an indicative data and the transmission of liquid crystal is adjusted by the driver circuit so that it may become a straight line mostly. However, it may become some curve as this straight line shows drawing 26 with dispersion in the permeability property of liquid crystal etc. Then, in order to amend the permeability property of such liquid crystal further, in the 2nd example, it considers as the configuration which shows the histogram detector 72 of drawing 18 to drawing 28 .

[0077] In drawing 28 , the threshold setting register 130 outputs two or more thresholds S1-S7 for comparing with the Y value 80 to comparator circuits 131-137. Moreover, as for each thresholds S1-S7, the value is set up freely. Comparator circuits 131-137 compare the Y value 80 with thresholds S1-S7, and output pulse signals 82-88 according to a comparison result respectively. Actuation of comparator circuits 131-137 is shown in Table 4.

[0078]

[Table 4]

表4

区分	Y値80		パルス出力
1	0≦Y値<S1	0～ 39	パルス信号82
2	S1≦Y値<S2	40～ 72	パルス信号83
3	S2≦Y値<S3	73～101	パルス信号84
4	S3≦Y値<S4	102～128	パルス信号85
5	S4≦Y値<S5	129～155	パルス信号86
6	S5≦Y値<S6	166～184	パルス信号87
7	S6≦Y値<S7	185～218	パルス信号88

When 80 is less than [with a Y values ofS1 or more S] two, a comparator circuit 132 outputs a pulse signal 83, as shown in Table 4, when the Y value 80 is less than [zero or more S] one, a comparator circuit 131 outputs a pulse signal 82, when 80 is less than [with a Y values ofS2 or more S] three, a comparator circuit 133 outputs a pulse signal 84, and each comparator circuit outputs a pulse signal according to each threshold like the following. Therefore, thresholds S1-S7 are texture ******** about each partition. Moreover, in Table 4, an example of the set point of thresholds S1-S7 is also united and indicated. Like an example of the set point of Table 4, the thresholds S1-S7 which classify the Y value 80 eight times serve as inequality spacing. This is for the inclination to the gradation data of a part with low transmission and a high part to amend the gradation property of the liquid crystal in which the inclination of the interstitial segment of transmission has a large gradation property small itself, as shown in drawing 26 . Therefore, it is necessary to give a gradation property as shown in drawing 2727 (a), and the small partition of the value of the Y value 80 and a large partition take the large width of face of a threshold, and in the partition of the in-between value of the Y value 80, thresholds S1-S7 are set up so that the width of face of a threshold may be taken narrowly. Thereby, as for the small partition of the value of the Y value 80, and a large partition, frequency becomes high relatively to the partition of the in-between value of the Y value 80. A gradation property is decided according to the frequency of each partition of a histogram, and a partition with higher frequency commits the gamma correction circuit of this invention so that the contrast of the partition may be emphasized more, as the 3rd example also described. Therefore, it becomes possible for a gamma correction circuit to operate to liquid crystal with the gradation property of drawing 26 , so that the gradation amendment itself may be amended, consequently to acquire a gradation property linear as a liquid crystal display.

[0079] Furthermore, it not only unites thresholds S1-S7 with the gradation property of liquid crystal, but in order to make it the whole gradation become bright like drawing 27 (b), it sets the whole gradation property as a property which becomes brighter to a linear property. Therefore, in the small partition of the value of the Y value 80, the large width of face of a threshold is taken, and thresholds S1-S7 are set up so that width of face of a threshold may be narrowed gradually, as it becomes the big partition of the value of the Y value 80. Thereby, in each partition of a histogram, frequency becomes high relatively to a big partition, and the small partition of the value of the Y value 80 works so that the contrast of gradation with the small value of the Y value 80, i.e., dark gradation, may be emphasized more. Therefore, a gradation property is set up so that the whole gradation may become brighter, and the bright liquid crystal display of a display is obtained.

[0080] As mentioned above, according to the 4th example of this invention, by changing a setup of the thresholds S1-S7 of the histogram detector 72, since gradation amendment which also took the gradation property peculiar to liquid crystal into consideration can be performed, the display of a gradation property linear as a liquid crystal display can be offered. It becomes possible to acquire the gradation property that brightness free as a liquid crystal display can be set up, by setup of thresholds S1-S7 furthermore.

[0081] Next, the 5th example of this invention is explained using drawing 29 and drawing 3030 . The 5th example is an example for easing the abrupt change of the gradation amendment property of the arbitration curvilinear gamma correction circuit 76 by change of an image scene in the movie display from which an image scene changes every moment.

[0082] The sign used for the approximate account of introduction each drawing and each drawing is explained. In addition, since the part of the same sign as the 3rd and 4th examples is as having already explained, explanation is omitted.

[0083] Drawing 29 is the block diagram of the liquid crystal display which applied the 5th example, and the low pass filter with which 140 eases the value change to the gradation control point 75, and 141 are the gradation control points which had change eased, and the gradation control point 141 is inputted into the arbitration curvilinear gamma correction circuit 76 explained also in the 3rd and 4th examples, and performs

gradation amendment.
[0084] Drawing 30 is the detailed block diagram of a low pass filter 140, and the delay circuit where 142 carries out one-frame period delay of a digital filter, and 143, 144 and 145, respectively, and 146 are the adders by which weighting was carried out. In addition, although drawing 3030 indicated the digital filter to the gradation control point L1, since the digital filter to other gradation control points L2-L7 is also the same configuration, explanation is omitted.
[0085] Next, actuation of the 5th example is explained.
[0086] In drawing 30 , the gradation control point L1 of the origin inputted into the digital filter 142 is inputted into a delay circuit 143. And to the original gradation control point L1, the output of a delay circuit 143 is outputted to a delay circuit 144 while it outputs the gradation control point L1 delayed one frame to an adder 146. Moreover, a delay circuit 144 is outputted to a delay circuit 145 while it outputs the gradation control point L1 delayed two frames to the original gradation control point L1 to an adder 146. Furthermore, a delay circuit 145 outputs the gradation control point L1 delayed three frames to the original gradation control point L1 to an adder 146. next, the gradation control point L1 by which delay was above-mentioned [of each] carried out carries out weighting of the adder 146, and it is added. One half of weighting is carried out to the original gradation control point L1, one fourth of weighting is carried out to the gradation control point L1 delayed one frame, one eighth of weighting is respectively carried out to the gradation control point L1 and the gradation control point L1 delayed three frames delayed two frames, and all are added. A concrete numerical example is explained using Table 5.
[0087]
[Table 5]

表５

フレーム	元の階調制御点	遅延回路１４３の出力	遅延回路１４４の出力	遅延回路１４５の出力	加算器１４６の出力
⋮	⋮	⋮	⋮	⋮	⋮
1	15	15	15	15	15
2	15	15	15	15	15
3	50	15	15	15	31
4	50	50	15	15	41
5	50	50	50	15	46
6	50	50	50	50	50
7	50	50	50	50	50
⋮	⋮	⋮	⋮	⋮	⋮

Table 5 shows the value of the output of the original gradation control point L1 for every frame, the gradation control point delayed respectively, and an adder 146, and the value of the gradation control point L1 assumes the case where what was "15" changes rapidly [a value] to "50" after the 3rd frame, to the 1st and the 2nd frame. Signs that it delays one frame at a time respectively the output of each delay circuits 143, 144, and 145 as shown in Table 4 are known. And weighting addition of the gradation control point delayed respectively is carried out with an adder 146, and the output of an adder 146 serves as a value as shown in Table 4. Consequently, "15", "31", "41", "45", "50", and its change are eased for that from which the value of the original gradation control point was changing to "50" rapidly from "15" from the 2nd frame to the 3rd frame from the 2nd frame to the 6th frame. The value of this eased gradation control point is outputted to the arbitration curvilinear gamma correction circuit 146 as a new gradation control point.
[0088] It is eased that a gradation correction curve changes rapidly with change of an image scene by using a low pass filter 140 as mentioned above, and since the property changes gradually to the image from which especially the image of an animation etc. changes every moment also in a gradation correction curve, it becomes possible to display a smooth image.
[0089] Next, the 6th example of this invention is explained using drawing 31 . After the 6th example stores a color video signal in a frame memory once and is delayed one frame, it is an example of the circuit which carries out gradation amendment.
[0090] Drawing 31 is the block diagram of the liquid crystal display which applied the 6th example of this invention, and a frame memory for 150 to carry out one-frame period delay of the color video signal 71 and 151 are the color video signals delayed one frame. In addition, since other parts are the same as what was

already explained in the 3rd and 4th example, explanation is omitted.
[0091] Next, actuation of the 6th example is explained. In drawing 31 R> 1, the inputted color video signal 71 is respectively inputted into the histogram detector 72 and a frame memory 150. The histogram detector 72 detects the histogram which shows the frequency of the brightness of the color video signal 71 that the 1st and 2nd examples described, and outputs the histogram value 73. And the gradation control point 75 is computed in the gradation control point calculation circuit 74 based on this histogram value 73, and the gradation amendment property of the arbitration curvilinear gamma correction circuit 76 is determined. The detected histogram value is latched and the histogram detector 72 outputs the histogram value 73, after detecting the histogram of the color video signal 71 of the frame concerned in order and inputting the color video signal 71 of the frame concerned altogether by one frame. Therefore, since the color video signal 71 of the next frame of the frame concerned will be inputted when the histogram value 73 is outputted, one histogram value 73 will be overdue in time to the corresponding color video signal 71. Therefore, one gradation control point which the gradation control point calculation circuit 74 outputs will also be overdue, and one decision of the gradation amendment property of the arbitration curvilinear gamma correction circuit 76 will also be overdue.
[0092] Then, the color video signal 71 is stored using a frame memory 150, and after carrying out one-frame period delay, the color video signal 151 is outputted to the arbitration curvilinear gamma correction circuit 76. Both the color video signal 151 inputted into the arbitration curvilinear gamma correction circuit 76 and the gradation control point 75 become what was overdue one frame. Based on this color video signal 151 that was overdue one frame, since the gradation control point 75 was computed, its gradation property of the color video signal 151 of the frame concerned corresponds in time as it is, it is reflected in the gradation control point 75, and this serves as the gradation amendment property of the arbitration curvilinear gamma correction circuit 76.
[0093] As mentioned above, in the 6th example, since a gradation amendment property is determined based on the gradation property of the color video signal of the frame concerned by having prepared the frame memory which delays one color video signal, gradation amendment with a more high precision can be performed, and a high definition liquid crystal display can be realized.
[0094] Next, the 7th example of this invention is explained using drawing 32 . The 7th example is an example which the color video signal 71 applied to the color video signal expressed with a Y/C signal (Y is brightness and C is the color difference) instead of the color video signal showing RGB.
[0095] Drawing 32 is the block diagram of the liquid crystal display which applied the 7th example of this invention, 90 is a color-difference signal, 161 is a brightness signal, and the color video signal 71 changes with a color-difference signal 160 and the brightness signal 161. 162 is the brightness signal by which gradation amendment was carried out, and 163 is a color decoder changed into the color signal of RGB from a color-difference signal 160 and the brightness signal 162. In addition, although it is this color decoder 163, it is the same as the so-called RGB matrix circuit changed into an RGB code from the Y/C signal widely built in the television receiver etc.
[0096] Next, actuation of the 7th example is explained. The color-difference signal 160 of the color video signal 71 is inputted into a color decoder 163. On the other hand, the brightness signal 161 is inputted into the histogram detector 72 and the arbitration curvilinear gamma correction circuit 76. Although it is the same as that of what was shown in drawing 19 like the 3rd example, since the signal inputted is already the brightness signal 161, Y value count circuit 79 of drawing 19 of the histogram detector 72 is unnecessary. Therefore, the brightness signal 161 inputted into the histogram detector 72 is inputted into the direct pulse generating circuit 81. The histogram detector 72 detects the histogram which shows the frequency of the brightness of the color video signal 71 that the 3rd and 4th examples described, and outputs the histogram value 73. And the gradation control point 75 is computed in the gradation control point calculation circuit 74 based on this histogram value 73, and the gradation amendment property of the arbitration curvilinear gamma correction circuit 76 is determined. And as for the brightness signal 161, a gradation property is amended by the arbitration curvilinear gamma correction circuit 76. And the arbitration curvilinear gamma correction circuit 76 is newly outputted to a color decoder 163 as a brightness signal 162. In addition, although it is the same as that of what was shown by drawing 22 like the 3rd example, since the signal inputted is already only the brightness signal 161, a broken line approximation circuit is good [the arbitration curvilinear gamma correction circuit 76] only at one line. A color decoder 163 is changed into the color display data 77 of RGB from the brightness signal 162 by which gradation amendment was carried out as mentioned above, and a color-difference signal 160. And this color display data 77 is inputted into the liquid crystal module 78, and an image is displayed.
[0097] As mentioned above, according to the 7th example of this invention, since gradation amendment is

performed according to the histogram of the brightness of the frame concerned to a brightness signal and amendment is not added at all to a color-difference signal, without generating, with high precision, only a brightness component can perform gradation amendment and, as for change of a hue, a blot of a color, etc. which twist gradation amendment, can realize a high definition liquid crystal display.

[0098] Next, the 8th example of this invention is explained using drawing 33 . The 8th example is an example of a configuration of having built the histogram detector 72, the gradation control point calculation circuit 74, and the arbitration curvilinear gamma correction circuit 76 in the liquid crystal module.

[0099] The approximate account and sign of introduction drawing 33 are explained. Drawing 33 is the block diagram of the liquid crystal display which applied the 8th example of this invention. The interface circuitry by which 171 is constituted from a histogram detector 72, a gradation control point calculation circuit 74, and an arbitration curvilinear gamma correction circuit 76, The data driver which outputs gradation driver voltage for 172 to display the liquid crystal panel with which the pixel has been arranged in the shape of a matrix, and the liquid crystal panel 172 corresponding to the color display data 77 in 173, The scan driver which outputs a scan electrical potential difference for 174 to display a liquid crystal panel 172, and 175 are liquid crystal modules which consist of the above-mentioned interface circuitry 171, a liquid crystal panel 172, a data driver 173, and a scan driver 174. In addition, since other parts are the same as what was already explained in the 3rd example, explanation is omitted.

[0100] Next, actuation of the 8th example is explained. In drawing 33 R> 3, an interface circuitry 171 carries out gray scale conversion of the inputted color video signal 71 to the color display data 77, and outputs it to the data driver 173. The color video signal 71 inputted into the interface circuitry 171 is inputted into the arbitration curvilinear gamma correction circuit 76 with the histogram detector 72. The color video signal 71 inputted into the histogram 2 investigates the frequency distribution of the brightness of the color video signal 71 in one frame, outputs the result as a histogram value 73, and outputs it to the gradation control point calculation circuit 74. The gradation control point 75 for the gradation property amendment given to the arbitration curvilinear gamma correction circuit 76 based on the histogram value 73 is calculated, and the gradation control point calculation circuit 74 is outputted to the arbitration curvilinear gamma correction circuit 76. The arbitration curvilinear gamma correction circuit 76 carries out gradation amendment of the color video signal 71 so that the relation between input gradation and output gradation may serve as a property defined at the gradation control point 75, and it outputs it to the data driver 173 as color display data 77. The data driver 173 is a circuit for changing the inputted color display data 77 into liquid crystal driver voltage, and making it output and display on a liquid crystal panel 102. On the other hand, the pixel arranged in the shape of a matrix is chosen and scanned for every line, the liquid crystal driver voltage outputted from the data driver 173 is impressed to each pixel in the line chosen by the scan driver 174, and the scan driver 174 displays on a liquid crystal panel 102. In addition, although an interface circuitry 171 is the same actuation as the histogram detector 72 of the 1st example, the gradation control point calculation circuit 74, and the arbitration curvilinear gamma correction circuit 76 and omits detailed explanation, it can be adapted for the histogram of the brightness of the color video signal 71 inputted by the interface circuitry 171, can emphasize the contrast of the gradation of the high partition of frequency on a histogram, and can attach the contrast of a display with a liquid crystal panel 172 by suppressing the contrast of the gradation of the low partition of frequency. And in order are adapted for a color video signal and to perform contrast control, it can respond also to various video signals. Since image scenes, such as an animation, can perform always optimal contrast control also in the video signal which changes one after another especially, it can express as the optimal image quality in consideration of the display property which a liquid crystal panel 172 has, or contrast. And the optimal liquid crystal module especially for animation display can consist of having built the interface circuitry 171 in the liquid crystal module 175 with the liquid crystal panel 172, the data driver 173, and the scan driver 174 in a compact.

[0101] It combines respectively and the 1st explained above - the 8th example can also be carried out.

[0102] For example, what is necessary is just to insert the low pass filter 140 of drawing 29 between the gradation control point calculation circuit 74 of the circuit of drawing 31 , and the arbitration curvilinear gamma correction circuit 76, when combining the 5th and 6th examples. Since a gradation amendment property is determined based on the gradation property of the color video signal of the frame concerned by having prepared the frame memory which delays one color video signal, the effectiveness of this example While being able to perform gradation amendment with a more high precision, by having prepared the low pass filter It is eased that a gradation correction curve changes rapidly with change of an image scene, and since it becomes possible to display a smooth image since the property changes gradually to the image from which especially the image of an animation etc. changes every moment also in a gradation correction curve, a high definition liquid crystal display is realizable.

[0103] Moreover, the color video signal 71 of an input of the 7th example is a Y/C signal. As this modification, the color video signal 71 of an input may install the color encoder which considers as an RGB code, inputs this and changes this into a Y/C signal once, and it may constitute it so that the Y/C signal which this color encoder outputs may be made into the color video signal 71 of drawing 3232 . In the modification of such 7th example, since gradation amendment is performed according to the histogram of the brightness of the frame concerned to a brightness signal and amendment is not added at all to a color-difference signal, without generating, with high precision, only a brightness component can perform gradation amendment and, as for change of a hue, a blot of a color, etc. which twist gradation amendment, can realize a high definition liquid crystal display.
[0104] It not only constitutes the interface circuitry 101 of the 8th example from a circuit of drawing 18 of the 3rd example, but furthermore, you may transpose it to the circuit by the 4th - the 7th example. In this case, the optimal liquid crystal module especially for animation display can consist of having built the interface circuitry 171 in the liquid crystal module with the liquid crystal panel, the data driver, and the scan driver in a compact.
[0105] Since it operates so that it may be adapted for the histogram of the brightness of the inputted color video signal, the contrast of the gradation of the high partition of frequency may be emphasized on a histogram and the contrast of the gradation of the low partition of frequency may be suppressed, in order according to the example of this invention are adapted for a color video signal and to perform contrast control in addition to the ability to attach the contrast of a display as mentioned above, it can respond also to various video signals. Since image scenes, such as an animation, can perform always optimal contrast control also in the video signal which changes one after another especially, it can express as the optimal image quality in consideration of the display property which a liquid crystal display has, or contrast, and a high definition liquid crystal display can be realized.
[0106] Since gradation amendment which also took the gradation property peculiar to liquid crystal into consideration can be performed still by enabling modification of a setup of the threshold of a histogram detector, the display of a gradation property linear as a liquid crystal display can be offered. It becomes possible to acquire the gradation property that brightness free as a liquid crystal display can be set up, by setup of a threshold furthermore.
[0107]
[Effect of the Invention] According to this invention, it becomes possible to set up brightness in a display more finely.

[Translation done.]

* NOTICES *

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] The schematic diagram of the system configuration of the display of the 1st example of this invention.
[Drawing 2] Detail drawing of the system configuration of the display of the 1st example of this invention.
[Drawing 3] Detail drawing of the system configuration of the luminance-signal generation section of the 1st example of this invention.
[Drawing 4] Detail drawing of the system configuration of the input picture-characteristics detecting element of the 1st example of this invention.
[Drawing 5] Detail drawing of the system configuration of the broken line point generation section of the 1st example of this invention.
[Drawing 6] The I/O brightness property Fig. of the broken line point generation section of the 1st example of this invention (1st example of a property).
[Drawing 7] Detail drawing of the system configuration of the input picture-characteristics feedback control section of the 1st example of this invention.
[Drawing 8] The I/O brightness property of the broken line point generation section of the 1st example of this invention (2nd example of a property).
[Drawing 9] The I/O brightness property of the broken line point generation section of the 1st example of this invention (3rd example of a property).
[Drawing 10] The I/O brightness property of the broken line point generation section of the 1st example of this invention (4th example of a property).
[Drawing 11] The I/O brightness property of the broken line point generation section of the 1st example of this invention (5th example of a property).
[Drawing 12] The I/O brightness property of the broken line point generation section of the 1st example of this invention (6th example of a property).
[Drawing 13] Detail drawing of the system configuration of the gradation operation part between the points of the 1st example of this invention.
[Drawing 14] It is a conceptual diagram in order to explain actuation of the gradation operation part between the points of the 1st example of this invention.
[Drawing 15] Detail drawing of the system configuration of the display of the 2nd example of this invention.

[Drawing 16] The conceptual diagram for explaining the back light light control of the 2nd example of this invention.
[Drawing 17] The flow chart of the back light light control of the 2nd example of this invention.
[Drawing 18] The block diagram of the liquid crystal display of the 3rd example of this invention.
[Drawing 19] The block diagram of the histogram detector of the 3rd example of this invention.
[Drawing 20] The block diagram of Y value count circuit of the 3rd example of this invention.
[Drawing 21] The block diagram of the gradation control point calculation circuit of the 3rd example of this invention.
[Drawing 22] The block diagram of the arbitration curvilinear gamma correction circuit of the 3rd example of this invention.
[Drawing 23] The graph of the histogram value outputted from the histogram detector of the 3rd example of this invention.
[Drawing 24] Drawing showing the relation between the input gradation of the arbitration curvilinear gamma correction circuit of the 3rd example of this invention, and output gradation.
[Drawing 25] Drawing showing the relation of the amount of light and electrical signal (electrical-potential-

difference actual value) which penetrate the liquid crystal of the liquid crystal display of the 3rd example of this invention.
[Drawing 26] Drawing showing the relation between the input indicative data (gradation data) of the liquid crystal display of the 3rd example of this invention, and the permeability of the light of liquid crystal.
[Drawing 27] Drawing showing signs that the partition of each histogram distribution is changed, to the relation between the input (gradation data) of the liquid crystal display of the 3rd example of this invention, and the permeability of the light of liquid crystal.
[Drawing 28] The detailed block diagram of the pulse generating circuit of the 4th example of this invention.
[Drawing 29] The block diagram of the liquid crystal display of the 5th example of this invention.
[Drawing 30] The detailed block diagram of the low pass filter of the 5th example of this invention.
[Drawing 31] The block diagram of the liquid crystal display of the 6th example of this invention.
[Drawing 32] The block diagram of the liquid crystal display of the 7th example of this invention.
[Drawing 33] The block diagram of the liquid crystal display of the 8th example of this invention.
[Description of Notations]
1 -- A picture-characteristics detecting element, 2 -- The breaking point generation section, 3 -- Broken line approximation gradation amendment section, 4 [-- Brightness / chrominance-signal separation control section,] -- A liquid crystal display panel, 5 -- A switching circuit, 6 -- An A/D converter, 7 8 -- A signal-processing control section, 9 -- The luminance-signal generation section, 10-12 -- Switching circuit, 13-15 -- An input picture-characteristics detecting element, 16-18 -- Broken line point generation section, 19-21 -- The gradation operation part between the points, 22 -- A synchronizing signal control section, 23 -- Microcomputer, 24 -- A microcomputer control section, 25 -- A liquid crystal module, 26 -- Detection period setting section, 27 -- The input gradation number-of-partitions setting section, 28 -- Input image data gradation field detecting element, 29 -- The 1st gradation field counter, 30 -- The 2nd gradation field counter, 31 -- The n-th gradation field counter, 32 -- The 1st data hold latch, 33 -- The 2nd data hold latch, 34 -- The n-th data hold latch, a 35--m time multiplication circuit, a 36--2*m time multiplication circuit, A 37--n*m time multiplication circuit, 38 -- An adder circuit, 39 -- n*m division circuit, 40 -- An average luminance data hold latch, 41 -- A size comparator circuit, 42 -- Size comparator circuit, 43 -- A dot-data latch circuit, 44 -- A dot-data latch circuit, 45 -- The maximum brightness data hold latch, 46 -- The minimum brightness data hold latch, 47 -- Input picture-characteristics feedback control section, 48 -- The light clock for broken line point setting registers, 49-57 -- Broken line point setting register, 58 [-- A switching circuit, 62 / -- A selector circuit, 63 / -- A selector circuit, 64 / -- A gradation operation control section, 65 / -- Back light control section.] -- A switching circuit, 59 -- The register for broken line point amendment data-hold, 60 -- The broken line point data generation section, 61

[Translation done.]

* NOTICES *

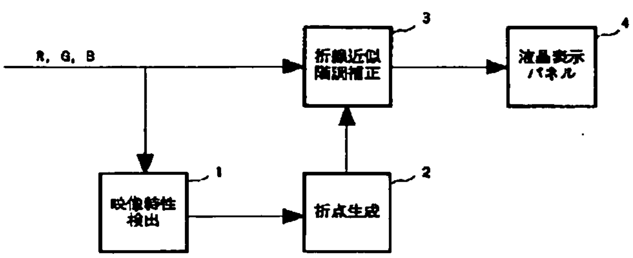
JPO and NCIPI are not responsible for any damages caused by the use of this translation.

1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

DRAWINGS

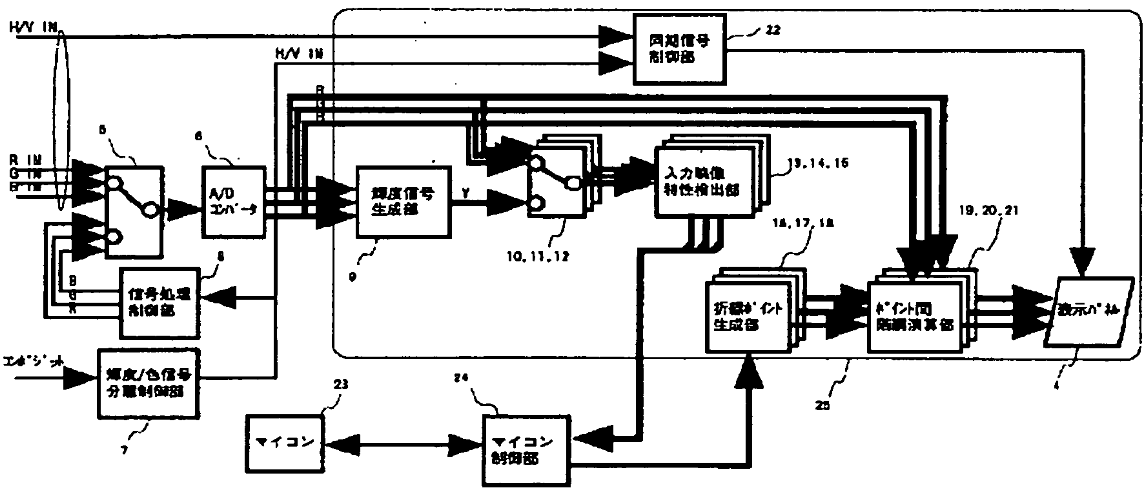
[Drawing 1]

図.1



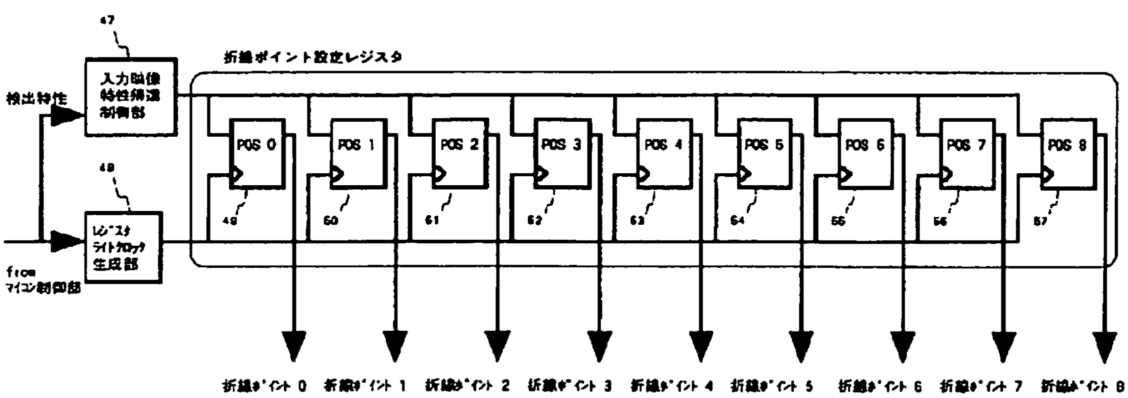
[Drawing 2]

図2



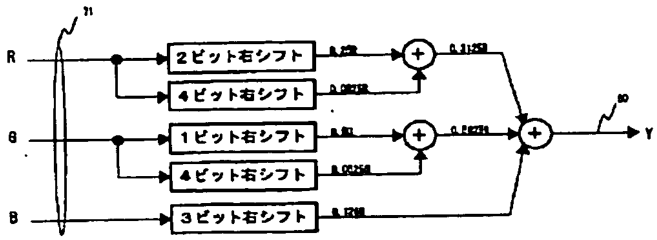
[Drawing 5]

図5



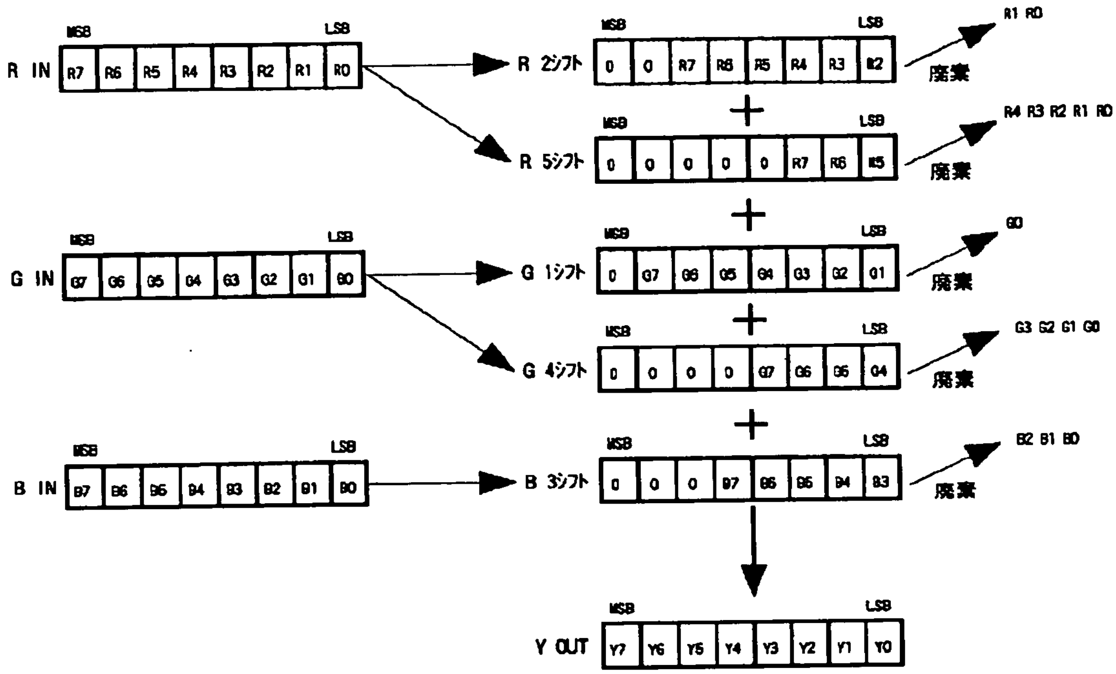
[Drawing 20]

図2D



[Drawing 3]

図3



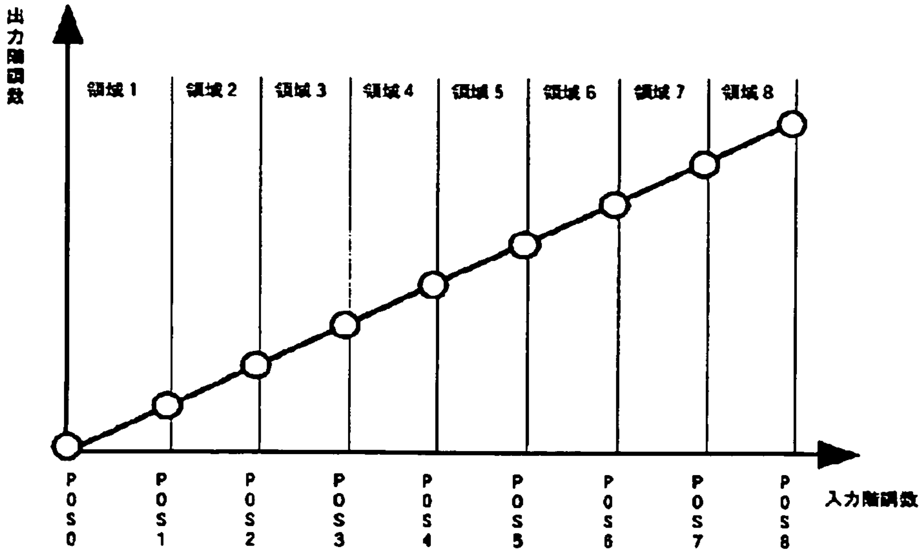
Y OUT = 0.299*R + 0.587*G + 0.114*B

近似処理

Y OUT = 0.281*R + 0.583*G + 0.125*B

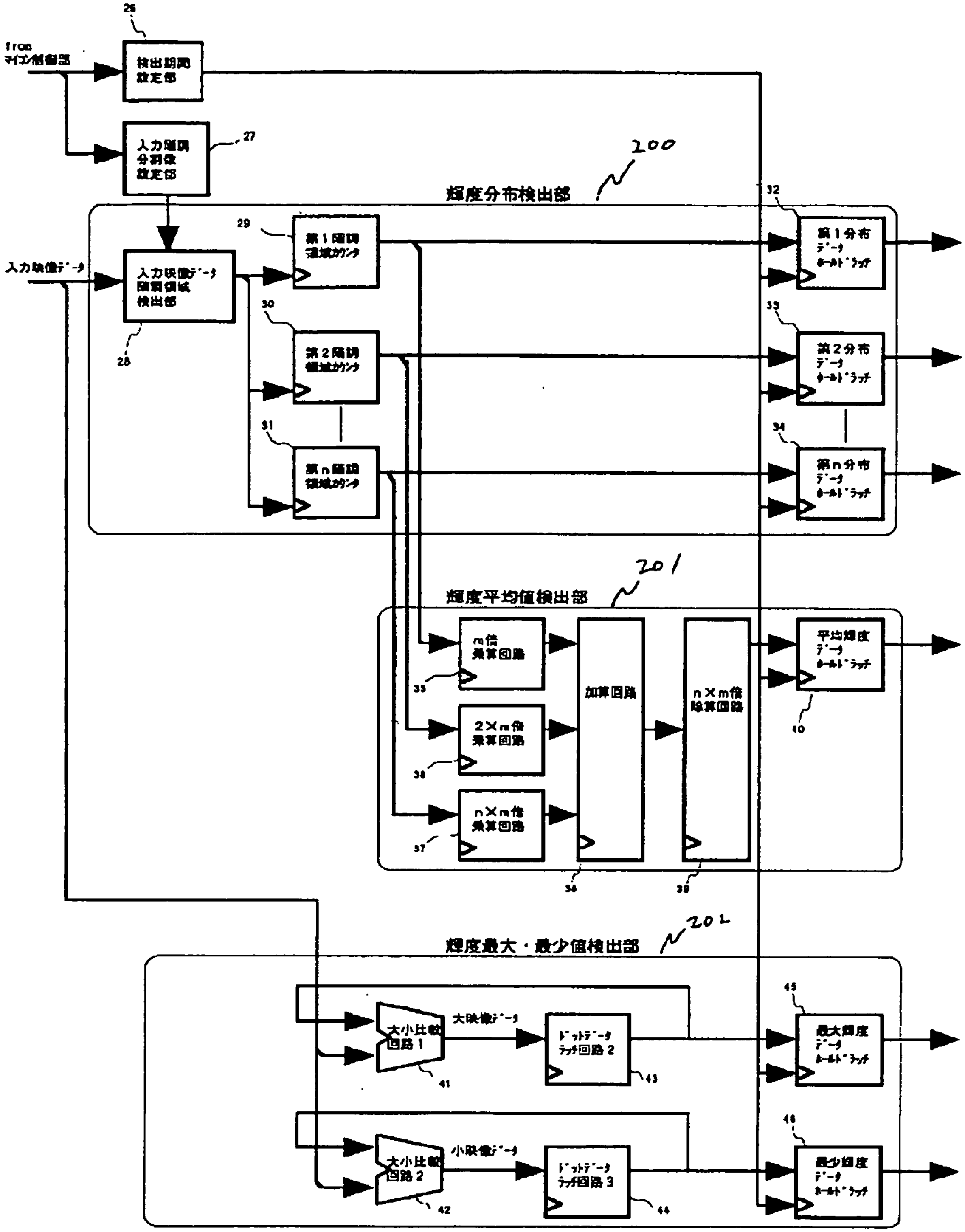
[Drawing 6]

図 6


出力階調数
領域 1
領域 2
領域 3
領域 4
領域 5
領域 6
領域 7
領域 8
POS0
POS1
POS2
POS3
POS4
POS5
POS6
POS7
POS8
入力階調数

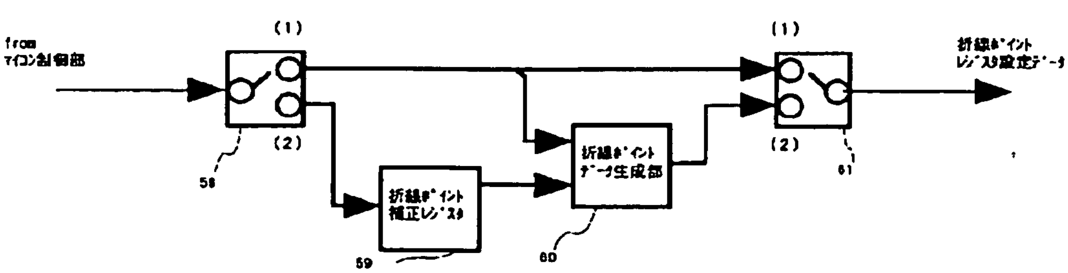
[Drawing 4]

図 4



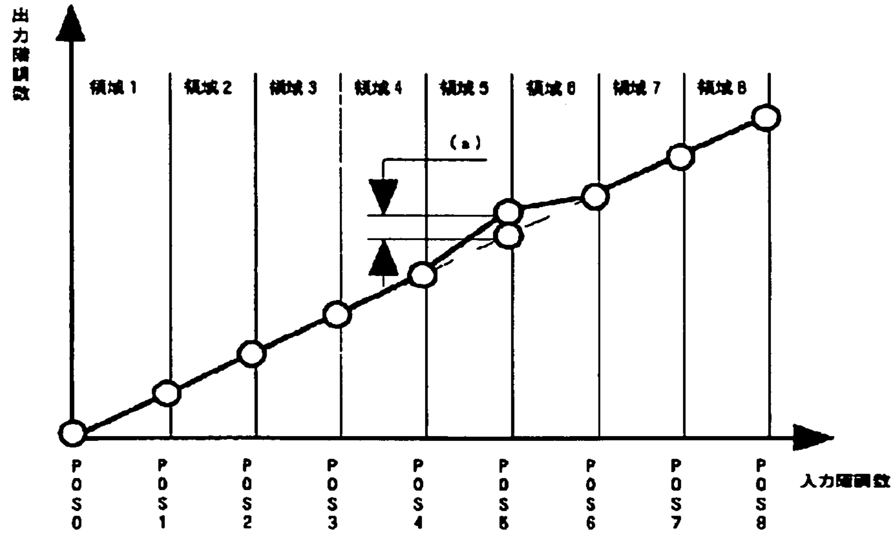
[Drawing 7]

図 7



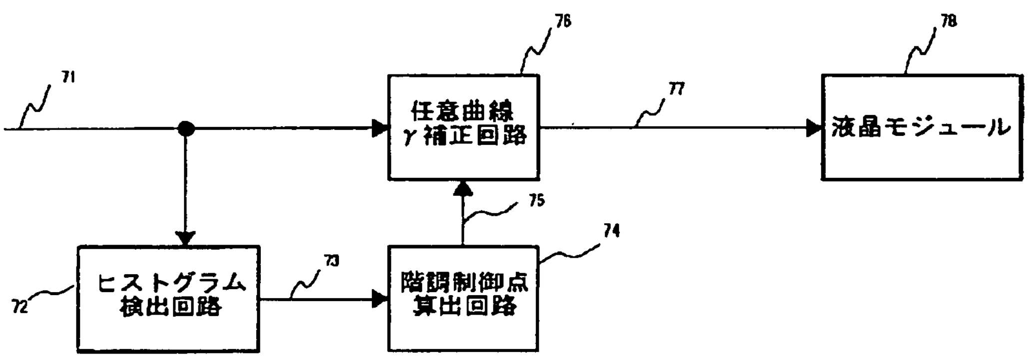
[Drawing 8]

図８



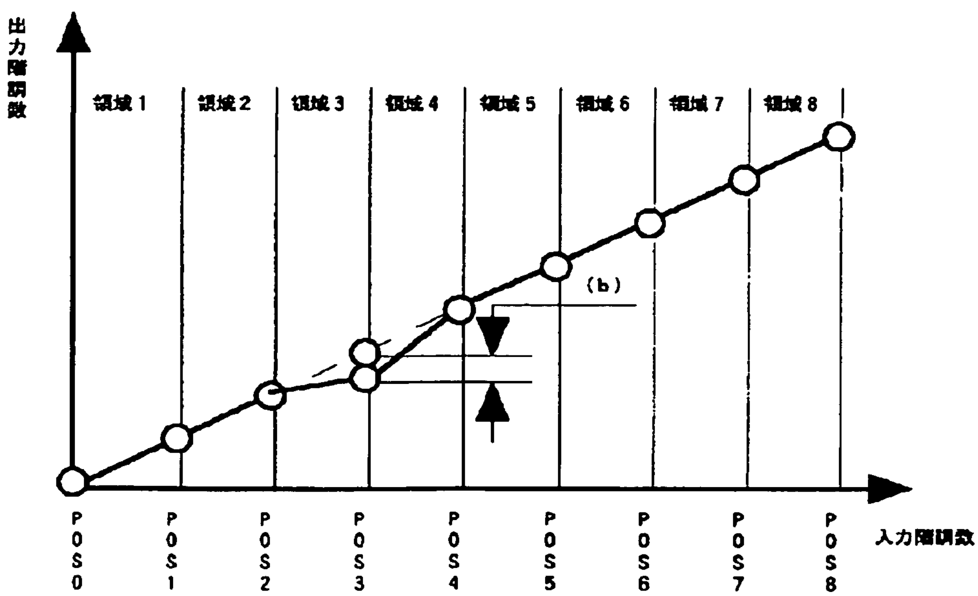
[Drawing 18]

図１８



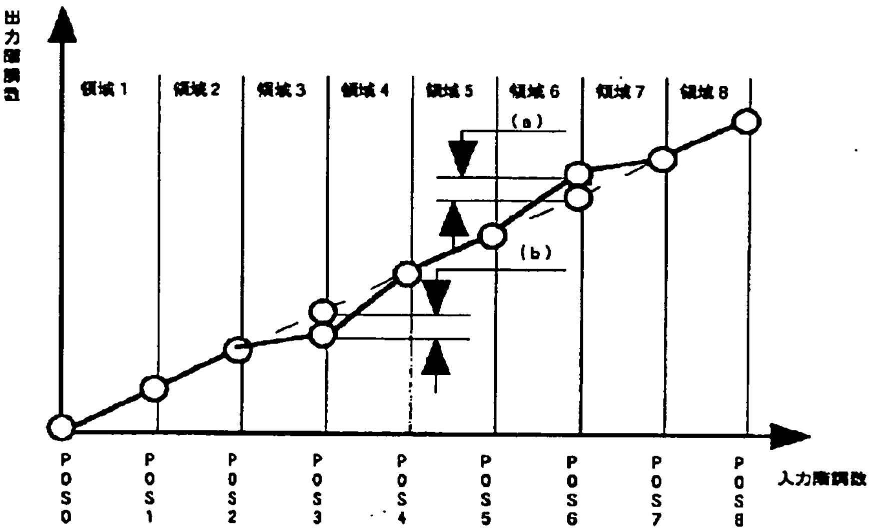
[Drawing 9]

図９



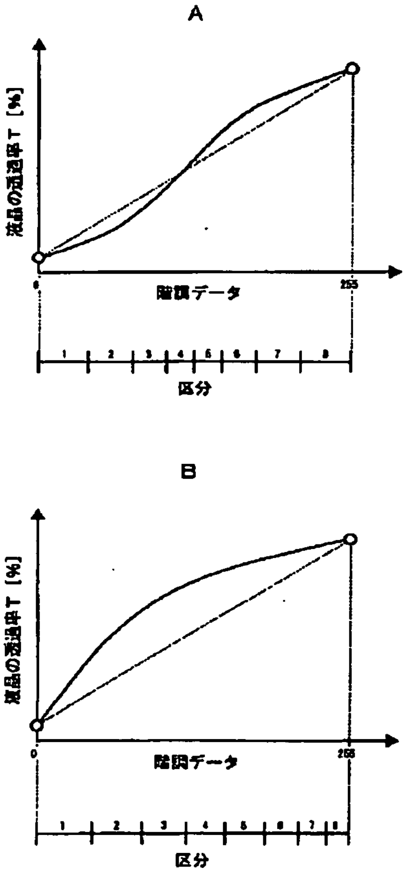
[Drawing 10]

図１０



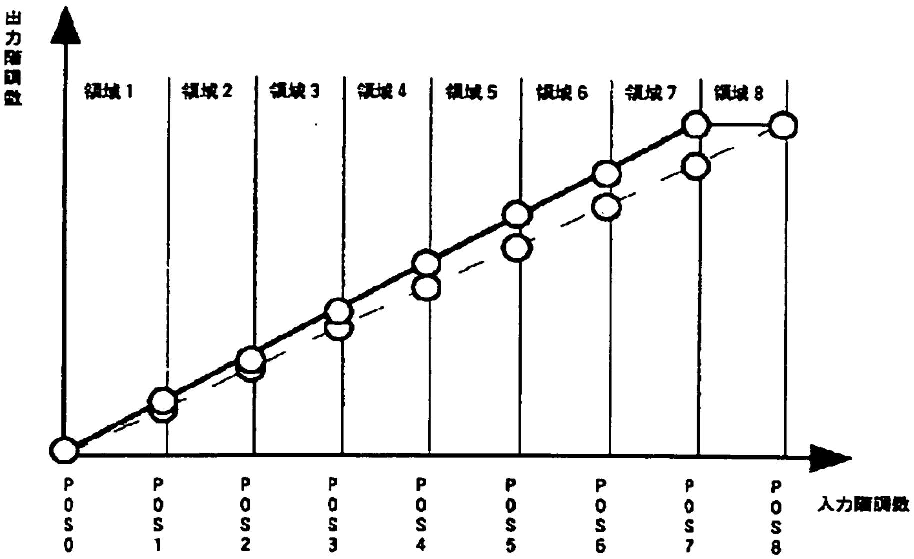
[Drawing 27]

図２７



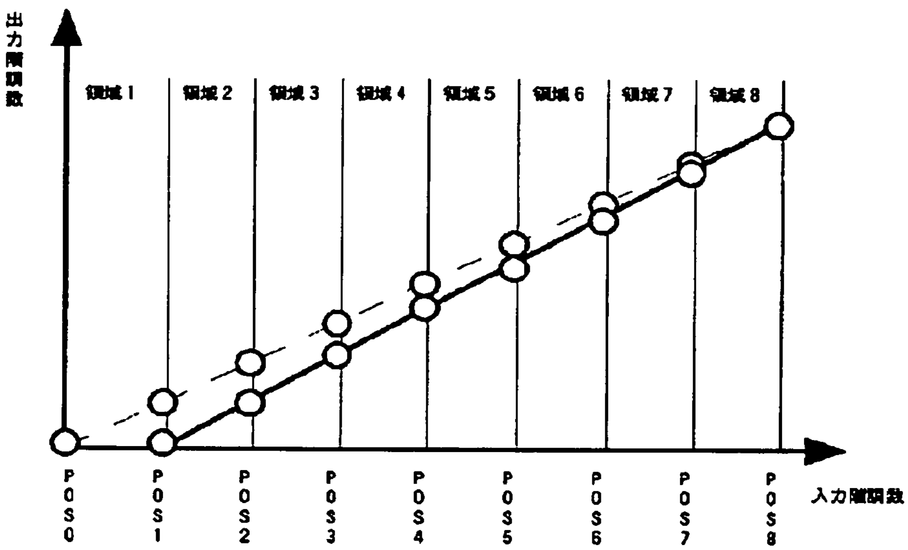
[Drawing 11]

図１１



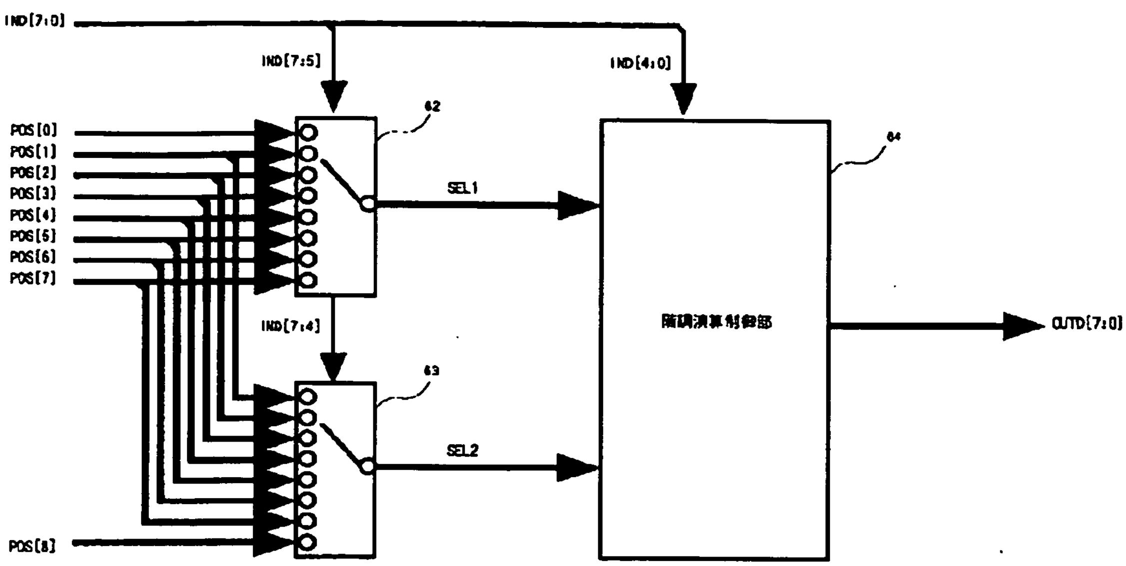
[Drawing 12]

図１２



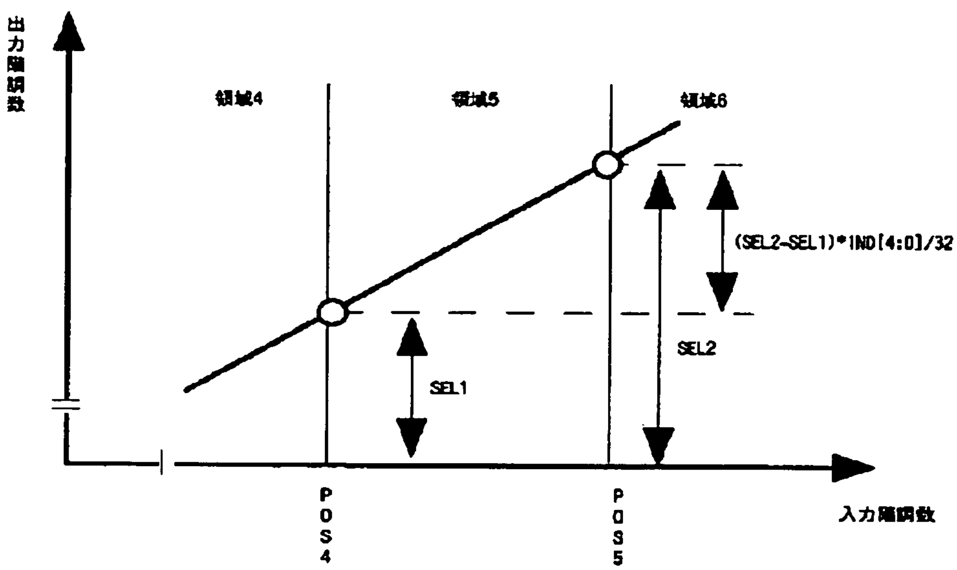
[Drawing 13]

図１３



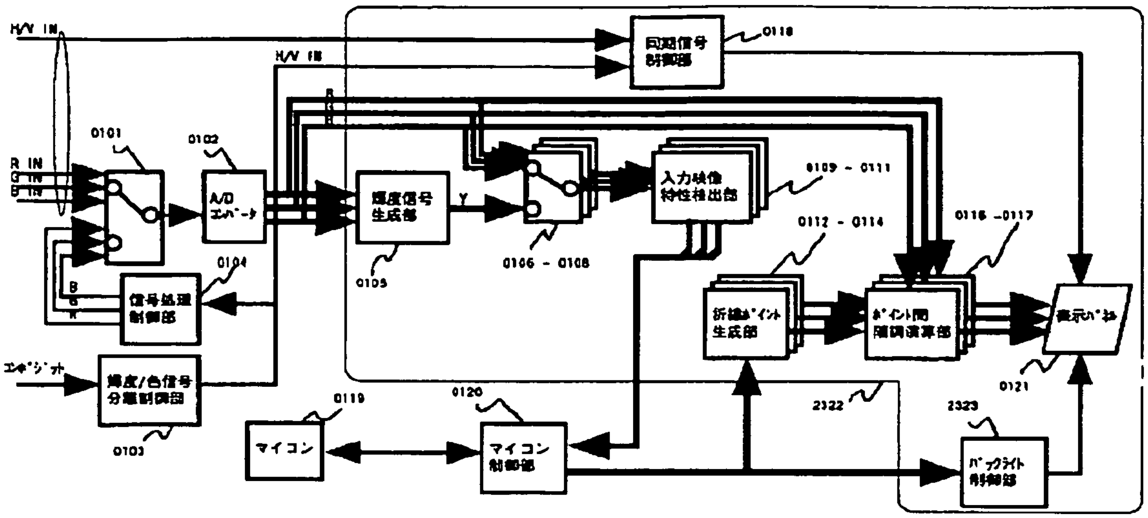
[Drawing 14]

図１４



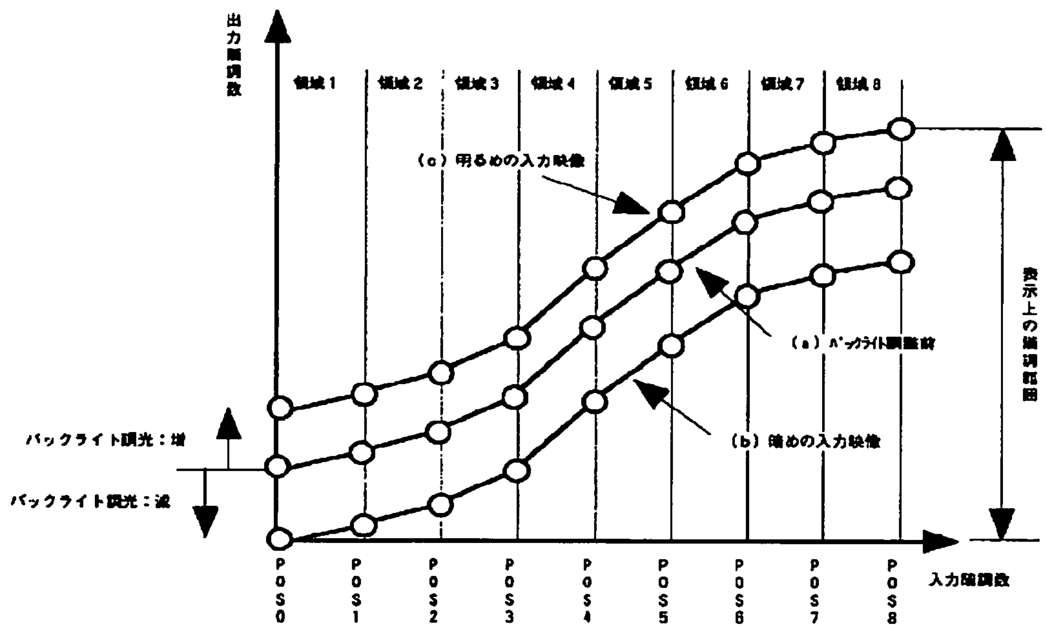
[Drawing 15]

図１５



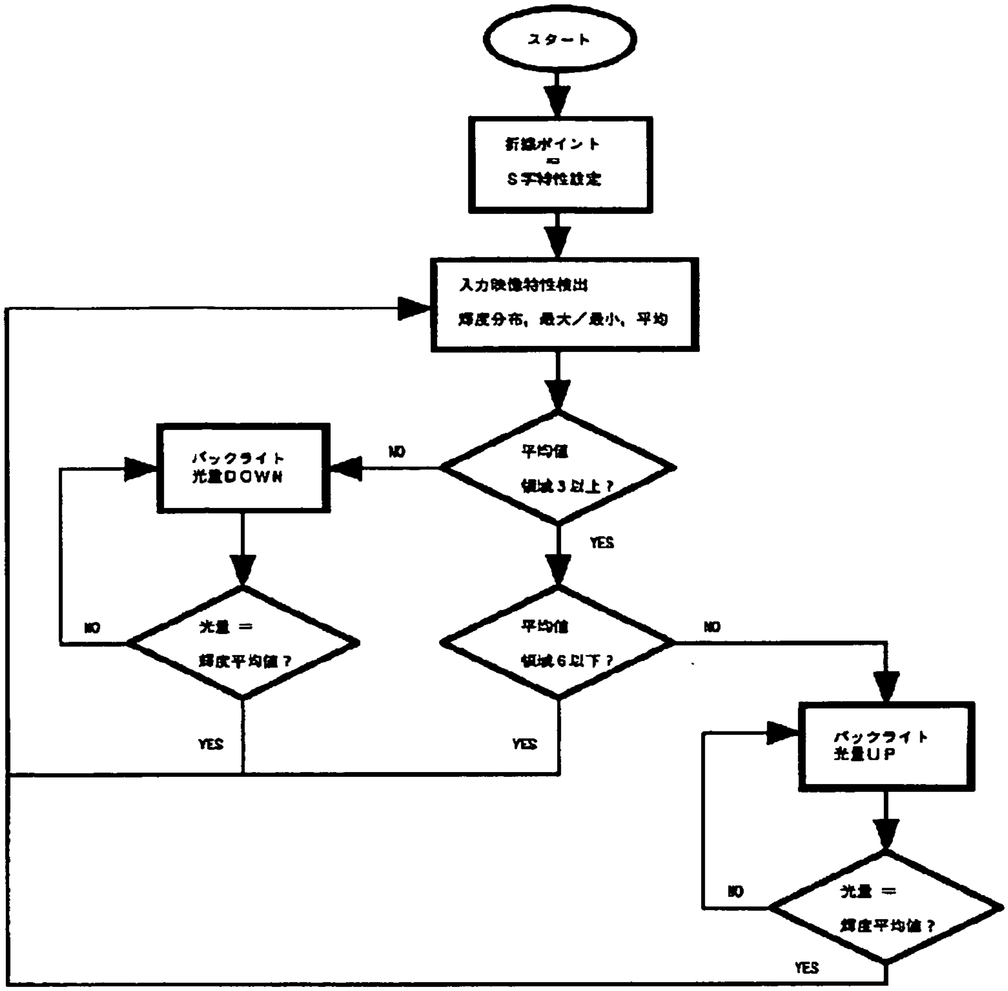
[Drawing 16]

図１６



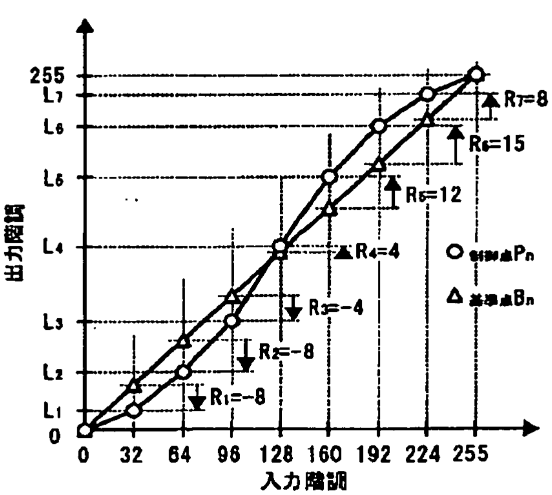
[Drawing 17]

図１７



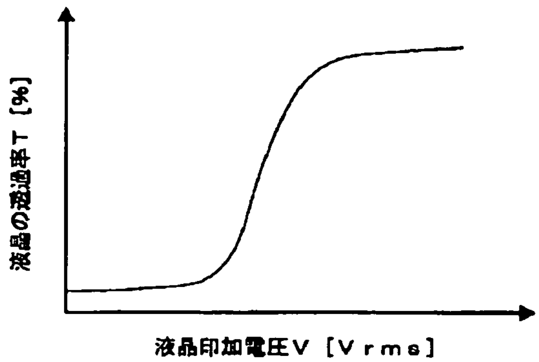
[Drawing 24]

図２４



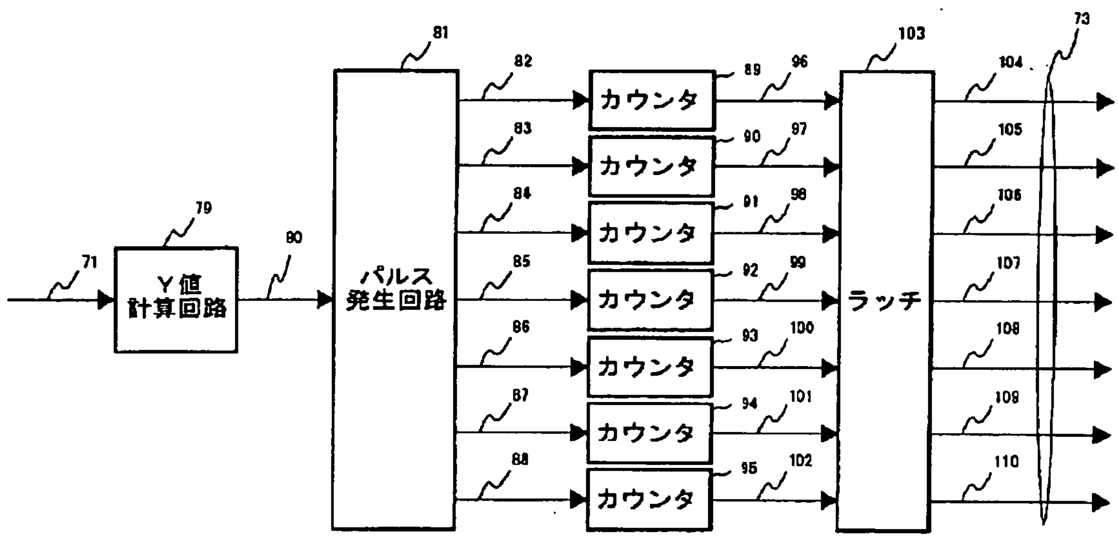
[Drawing 25]

図２５



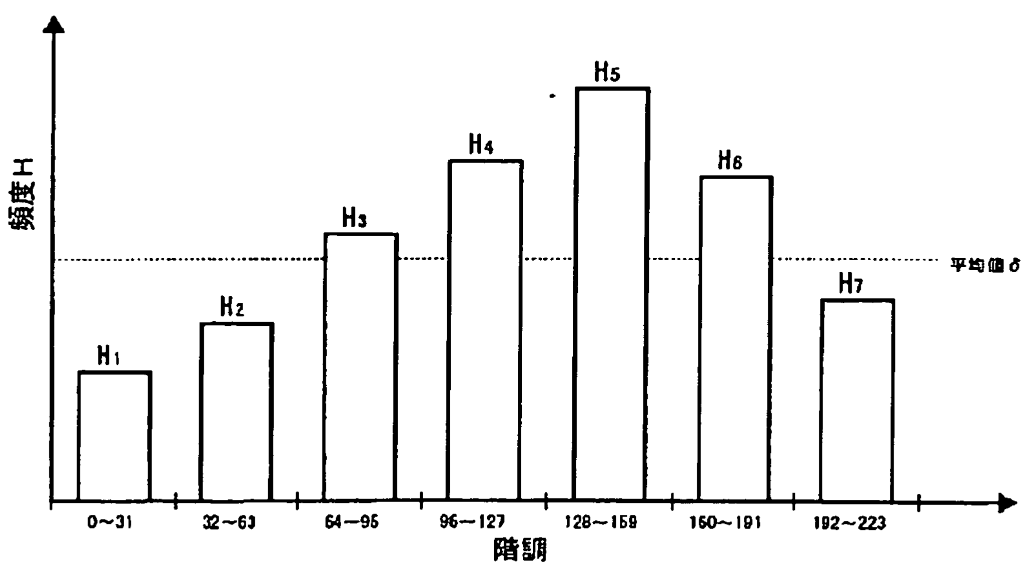
[Drawing 19]

図１９



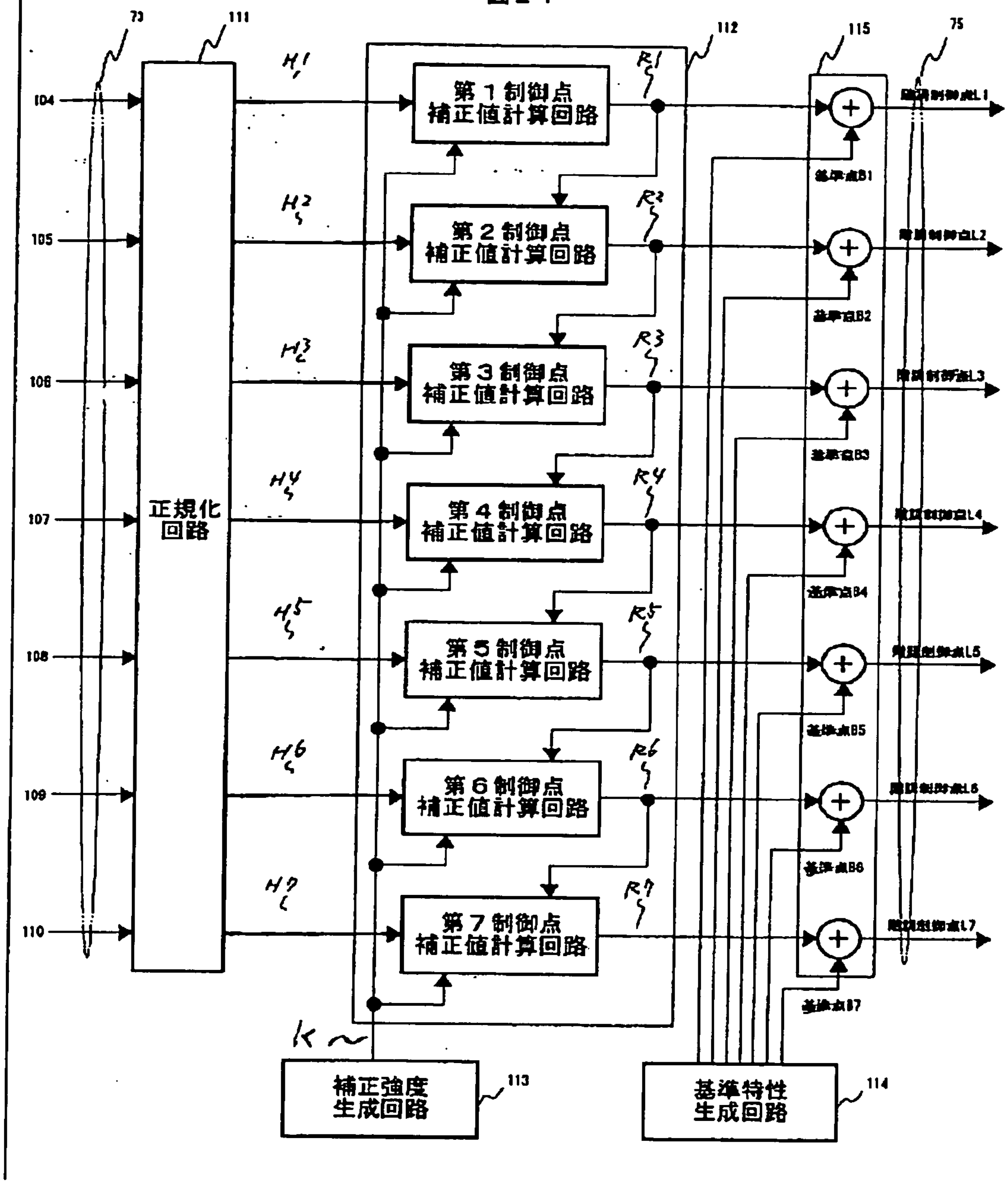
[Drawing 23]

図２３



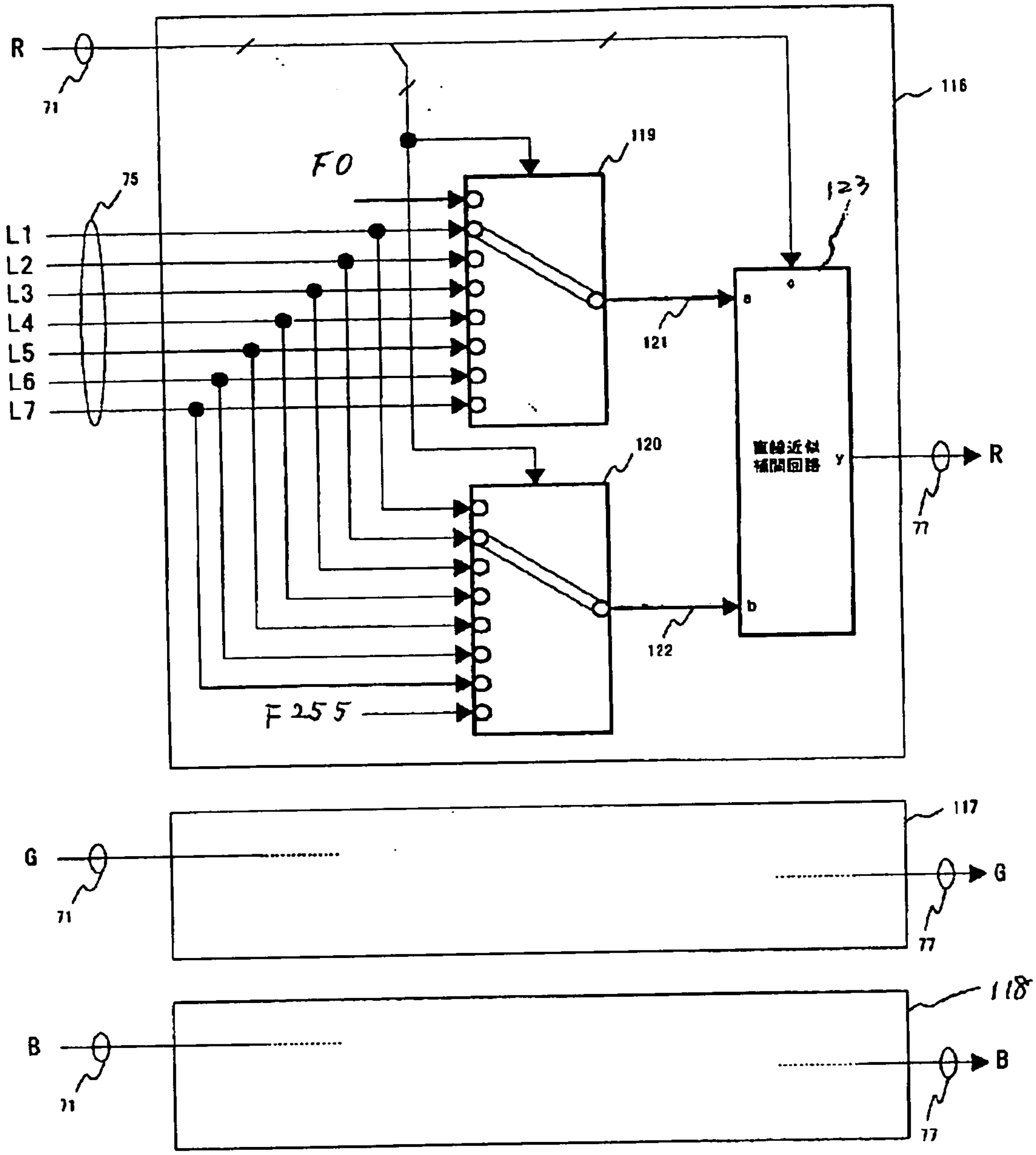
[Drawing 21]

図２１



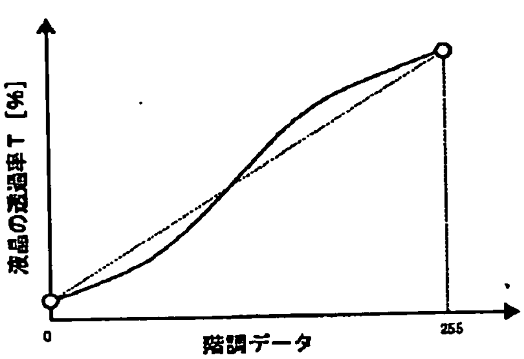
[Drawing 22]

図２２



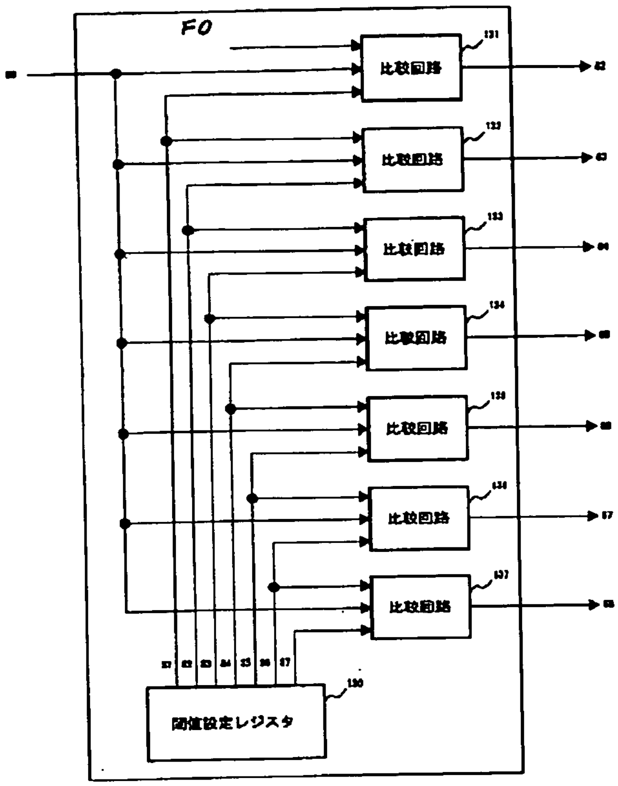
[Drawing 26]

図２６



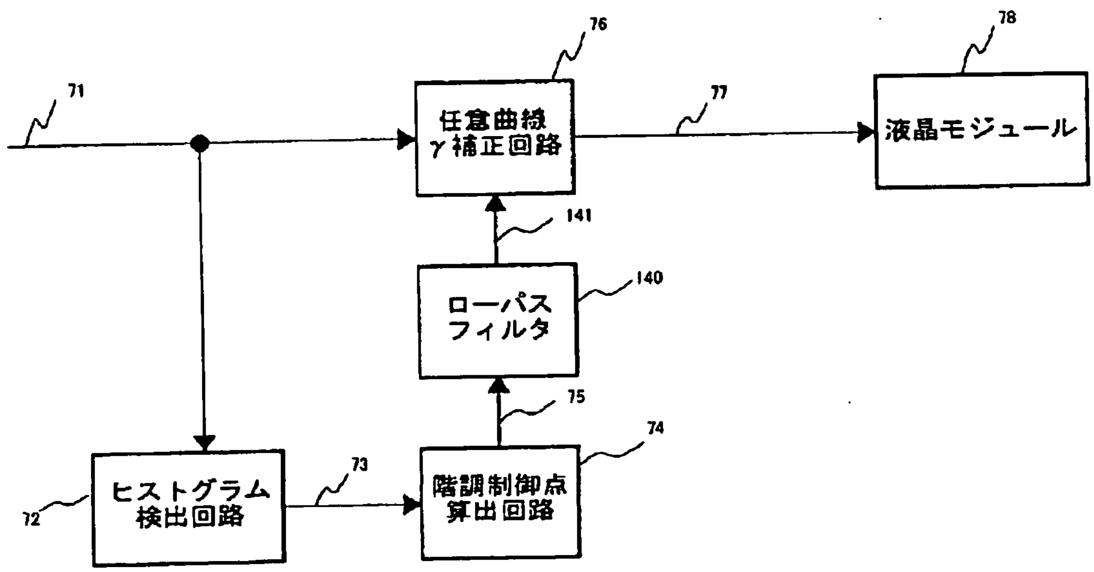
[Drawing 28]

図２８



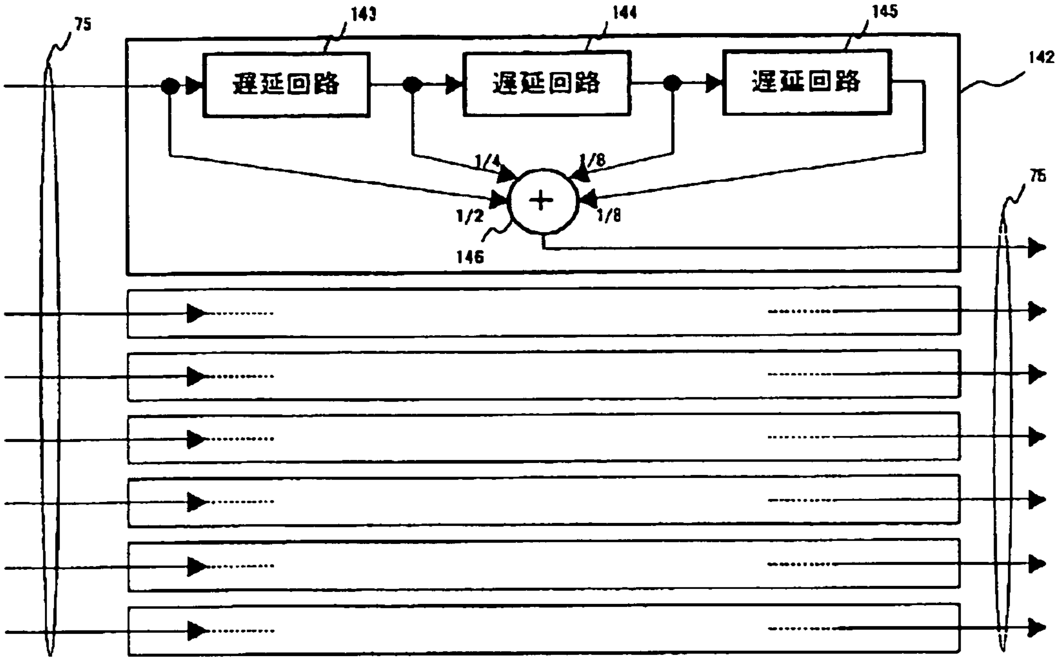
[Drawing 29]

図２９



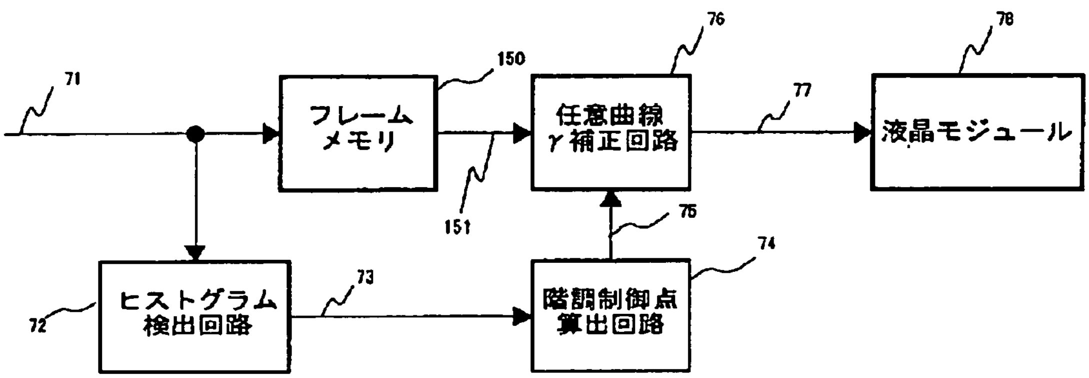
[Drawing 30]

図３０



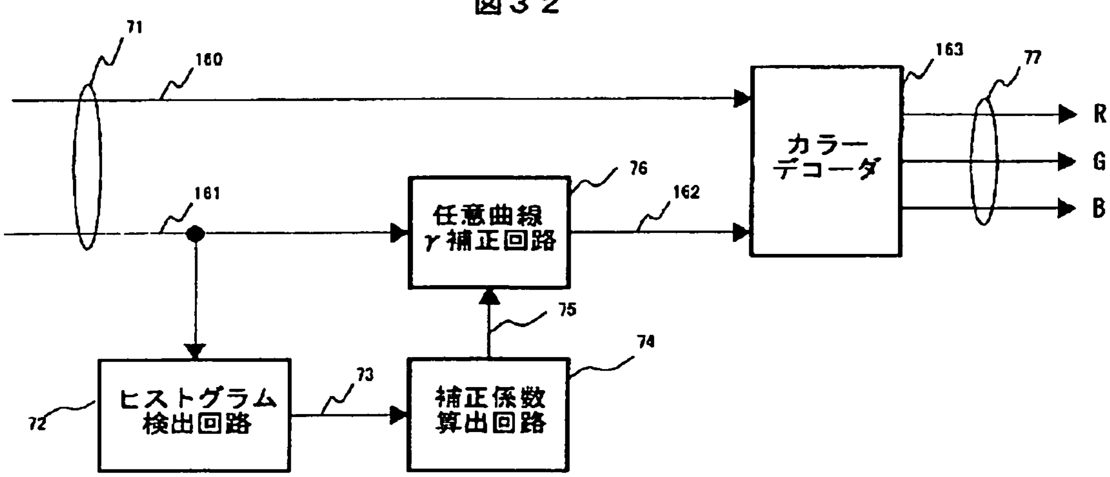
[Drawing 31]

図３１



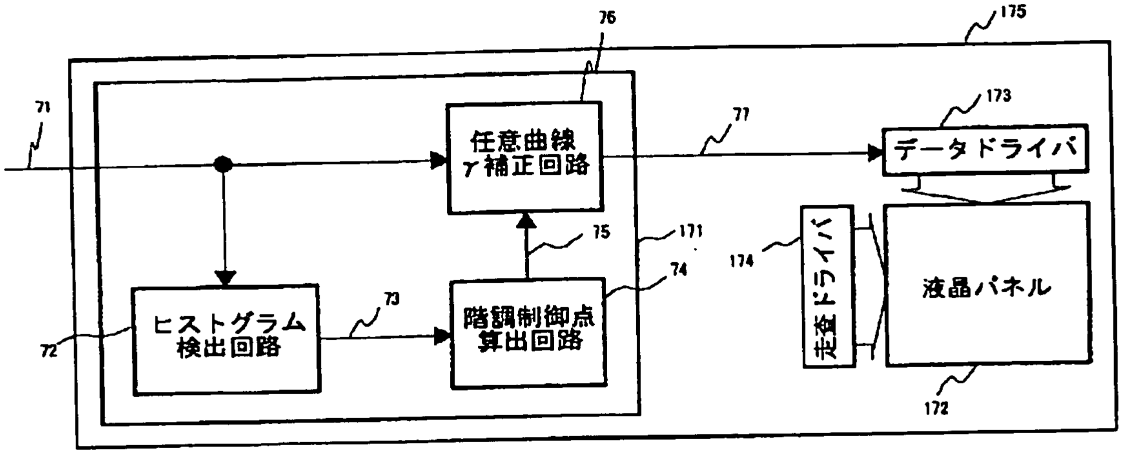
[Drawing 32]

図３２



[Drawing 33]

図３３



[Translation done.]